A NATIONAL ASSESSMENT OF THE INTRASTRUCTURE FOR URBAN WILDLIFE MANAGEMENT

A Thesis

by

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ABSTRACT

North America is currently the most urbanized geographical area in the world, with over 82% of the population living in urban areas. Urbanization has led to a profound change in many ecosystems and associated wildlife across the nation and has altered the human perspective of the environment. Urban wildlife management is an emerging field of ecology that addresses the human dimension in urban wildlife ecosystems, taking into account human perspectives as well as wildlife needs in urban ecosystems. Universities and state wildlife agencies are the main driving forces for research and management, and it is crucial that these institutions provide support for managing wildlife in urban environments.

Universities (n = 73) and state wildlife agencies (n = 50) in each state across the nation were surveyed to: 1) to assess whether a structure for urban wildlife management at state DNRs and universities across the U.S. existed; 2) compare current infrastructure for urban wildlife management to the infrastructure present prior to 2000; and 3) determine how current infrastructure for urban wildlife management might be related to other national trends including level of urbanization, economic loss due to urban wildlife, and participation in wildlife-related activities.

The majority of these respondents agreed there was a public demand for urban wildlife management in their state and that their institution was involved in urban wildlife management concerns. However, respondents reported a total of only 126 full time urban wildlife biologists (compared to 8,451 traditional biologists) in state wildlife

agencies and universities across the nation. Though there are still few urban wildlife biologists within state agencies or universities, the average number of urban wildlife biologists per institution has doubled since 1999. Indicators of infrastructure for urban wildlife management within state agencies and universities were unrelated to other national trends that were considered for the scope of this study.

Despite limitations including lack of funding, competing wildlife issues, and poor communication, organizations should be more involved with addressing urban wildlife management concerns. State wildlife agencies and universities need to establish clear support and communication for urban wildlife needs. Though expansion in this area has occurred in the last two decades, there are growing urban wildlife concerns that should be addressed with focused attention by leading wildlife institutions.

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NOMENCLATURE

DNR: Department of Natural Resources; also referred to as state agencies.

Infrastructure: The framework of networks and systems that produces essential products and services that allow for a smooth functioning system within society (Executive Order 14010, 1996). Applied to urban wildlife management, it is the foundation of organizations and services that produces urban wildlife-related services for the public and allows for the management of wildlife in urban areas.

Institutions: Refers collectively to DNRs and universities.

Urban: All territory, population, and housing units located within an urbanized area or an urban cluster. Urbanized areas or urban clusters consist of center blocks that have a population density of at least 1,000 people per square mile with surrounding census blocks that have an overall density of at least 500 people per square mile (U. S. Census Bureau, 2010).

Urban Wildlife: animals living within urban areas that utilize the resources of urban settings to complete their life cycles (Adams, 2003).

Urban Wildlife Biologist: an individual who works or conducts research primarily in urbanized environments with a focus on non-domestic vertebrate and invertebrate species as well as human associations with wildlife (including education and conflict resolution)

Urban Wildlife Management: an emerging field of ecology that addresses the human dimension in urban wildlife ecosystems, taking into account human perspectives as well as wildlife needs in urban ecosystems.

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1. INTRODUCTION

1.1. American society's march towards urbanization

The Neolithic Era marked the rise of early urban centers, with the development of a social organization apart from agriculture in which individuals such as government officials, traders, and artisans were no longer tied to the land (Davis, 1955). This movement from a completely agrarian lifestyle to one disassociated from the land marked the beginning of urbanization and the separation of mankind and the environment. Though increased urbanization occurred slowly throughout time and civilizations, the main shift in the U.S. from a largely agrarian to urban society occurred towards the end of World War II (Adams, 2003). This change was stimulated by a number of factors including the development of highway networks in and around cities, affordable automobiles, cheap fuel, and the ability to produce and harvest crops with minimal human effort (Adams, 2003).

As a result, North America is currently the most urbanized geographical area in the world, with over 82% of the population living in urban areas (United Nations, 2011). The percentage of North Americans in urban (and suburban) areas is projected to increase to almost 90% by 2050 (United Nations, 2011). The increase in suburban expansion and urban sprawl has contributed to expansion of what is known as the wildland-urban interface, leading to more human-wildlife conflict and altered ecosystems. This rapid rate of urbanization has led to profound change in many

ecosystems across the nation and has altered human perspective of wildlife and the environment (Czech, Krausman, & Devers 2000; Adams 2003).

1.2. Human disconnect from nature

As society became urbanized, humans lost their agrarian ties to the environment and became more isolated from the natural world (Adams, 2003; Adams, 2005). Urban areas, characterized by landscapes devoted to all things man-made or maintained, include densely packed blocks filled with buildings, cemeteries, vacant lots, strip malls, industrial districts, and offices (Adams & Lindsey, 2010). With the development of buildings, factories, warehouses, power lines, and airports, society has distanced itself from nature and lost many of the values imparted by early conservationists such as Aldo Leopold, Henry David Thoreau, and John Muir.

Noted author Richard Louv described this trend of urbanization and isolation from nature as *nature-deficit disorder*, exhibited by a change in the American experience of nature from "direct utilitarianism to romantic attachment to electronic detachment" (Louv, 2005). Few in contemporary society understand the source of the resources used for daily activities such as eating breakfast or using water; fewer understand what impact those actions have on wildlife and natural processes (Adams, 2003). People, particularly children, seek entertainment indoors by watching television or surfing the internet rather than exploring the environment (Louv, 2005). Citizens in urban environments miss the opportunity to connect with wildlife and the natural world on a daily basis, and as a result, have a lack of understanding about the environment.

Coyle (2005) estimated that approximately 1-2% of adults in the United States (U.S.) can be considered environmentally literate (able to investigate and apply information acquired from an environmental subject). Surveys have shown that Americans have little knowledge of basic environmental facts, processes, or important environmental issues, and only one-third of American adults can pass a simple test containing basic questions about the environment (Coyle, 2005). Few high school students can correctly identify common urban wildlife species or understand human effects on urban wildlife (Adams, 1987). This lack of understanding is a primary reason why the average American struggles to make informed decisions about wildlife and public environmental issues, particularly in urban environments.

1.3. Need for education in urban areas

Though the majority of Americans have little understanding of wildlife and environmental issues, over 95% of the public support environmental education in schools, 85% believe the government should support environmental education programs, and 80% believe that private companies should train employees to interpret and solve environmental problems (Coyle, 2005). This demonstrates the realization that there is a need for environmental education, particularly considering the increasing population growth and subsequent consumption of resources. Education programs are crucial to promote conscientious natural resource utilization and show the public how to become better stewards of the environment (Vaughan, 1993). Without an understanding of

wildlife and natural processes, humans are unable to make rational decisions concerning human-wildlife encounters or resource management.

Programs that educate citizens about the environment help equip people to make sustainable decisions concerning wildlife and natural resources. Community based programs focused on urban wildlife and habitat such as Texas Master Naturalist™ , Master Gardener, Watchable Wildlife, and Master Watershed Stewards can offer ways for the public to connect with and learn about the environment as well as contribute to citizen science (Adams, 2003). Educational curricula incorporated into school systems such as Project WILD, Aquatic WILD, Project WET, and Project Learning Tree introduce grade-level students to the basics of wildlife and conservation (Adams, 2003). Multiple studies have shown that environmental education and increased environmental knowledge helps improve students' attitude and connectedness with the environment (Bradley, Waliczek, & Zajicek, 1999; Ernst & Theimer, 2011; Liefländer, Fröhlich, Bogner, & Schultz, 2013).

Though environmental education programs and curricula have been implemented in the U.S., funding available to support these programs proves inadequate and as a result these programs effectively reach only a small percentage of environmentally illiterate American citizens (Potter, 2010). The majority of citizens in this country still do not understand environmental issues, personal responsibility and stewardship for the environment, and the importance of involvement and action (Potter, 2010). Urbanites oftentimes have misconstrued views of wildlife and the environment, leading to a misuse of resources and human-wildlife conflicts. Lack of exposure to wildlife can cause

urbanites to misinterpret wildlife behavior, which can lead to the injury or harassment of either the wildlife or human (Adams, 2003). Because environmental education can cause a lasting change in the way people perceive and behave towards natural resources, it is imperative that wildlife institutions implement more environmental programs and curricula about the urban environment in order to promote a more environmentally literate society (Coyle, 2005).

1.4. Effect of urbanization on wildlife

Collins et al. (2000) described cities as being "some of the most profoundly altered ecosystems on the planet" along with containing a diverse array of ecological conditions. These drastically altered ecosystems have resulted in both extirpated species as well as allowed some species, including non-natives, to thrive and increase to nuisance levels (Adams, 2005; Czech et al., 2000). Indeed, some urban environments have allowed for the propagation of certain species (native and non-native) beyond desirable levels, including the house sparrow (*Passer domesticus*), white-tailed deer (*Odocoileus virginianus*), and house mouse (*Mus musculus*; Adams, 2003). Urbanization was listed as the second highest cause of species endangerment for American species listed as threatened or endangered by the U.S. Fish and Wildlife Service (Czech et al., 2000).

Urbanization causes changes in animal community structure: alterations in animal biomass, migration patterns, circadian activity, and recruitment rates (Adams, 2005). Changes in a species' habitat due to urbanization can be caused by pollution,

habitat fragmentation, modified disturbance regimes, the introduction of new predator and prey species, in addition to introduction of disease (Czech et al., 2000). Cities and urban environments also increase the possibility of human-wildlife encounters and conflict. Typically when human-wildlife conflict occurs, both parties are negatively impacted (Conover, 2002).

1.5. Wildlife in urban areas affects humans

The urban environment has created a new niche for wildlife species, which can impact humans in a variety of ways. Wildlife can cause economic loss, physical damage, human injuries, discomfort, and disease (Conover, 2002). Bird feeders in backyards attract unwanted snakes, hawks, and mammals including raccoons (*Procyon lotor*), rodents, and cats (*Felis spp*.; Adams 2003). Flocks of thousands of birds in urban environments such as geese (Family Anatidae) or starlings (*Sturnus vulgaris*) can deposit large quantities of fecal matter over trees, buildings, vehicles, lawns, and sidewalks. People not only find this type of behavior annoying, but it can also pollute water impoundments and cause sanitation problems (Adams & Lindsey, 2010).

Beaver (*Castor canadensis*) can improve water quality and construct wetlands by building dams, but they can also inadvertently cause roadway flooding, plug culverts, and damage bridges (Newbill & Parkhurst, 2009). Large animals including deer and moose (*Alces alces*) provide hunting and wildlife viewing benefits, but contribute to 1 – 2 million vehicle collisions annually (Huijser, McGowen, Fuller, Hardy, Kociolek,

Clevenger, Smith, & Ament, 2008; Adams & Lindsey, 2010; Hothorn, Brandl, & Muller, 2012).

Humans benefit from wildlife economically, recreationally, scientifically, and ecologically (Conover, 2002). Though these many types of human-wildlife conflict occur, most individuals believe the natural world is connected to quality of life and relates to human mental, physical, and moral well-being (Buzzell & Chalquist, 2009; Kellert, 2005). Ecotherapy has emerged as a new vision of human health, and psychologists as well as scientists have started to see that nature experiences may reduce stress, anxiety, depression, and attention deficits (Kellert, 2005; Louv, 2005, Buzzell & Chalquist, 2009).

A large percentage of the nation participates and benefits from recreation associated with wildlife. The 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation reported that more than 90 million U.S. residents participated in wildlife-related recreation, spending approximately $145 billion dollars on wildlife-related activities (U.S. Department of the Interior, U.S. Fish and Wildlife Service, U.S. Department of Commerce, & U.S. Census Bureau, 2011). Approximately one-third of all U.S residents in 2011 viewed wildlife in the area around their homes, with 70% of those individuals feeding birds (U.S. Department of the Interior et al., 2011).

1.6. Necessity of urban wildlife management

The rapid rate of urbanization in the U.S. has made urban wildlife management crucial for today's society, both to increase the value of wildlife resources as well as to

protect them for future generations (Conover, 2002). Traditional wildlife management strategies used in rural areas are not completely applicable to urban areas, given the added human dimension as well as the differences in animal community structure and life history exhibited in urban ecosystems (Table 1.1; Adams, 2003; Adams & Lindsey, 2010). There are many differences between wildlife management in urban and rural settings, and as a result there needs to be a separate emphasis on managing urban wildlife (Table 1.1).

Wildlife management in urban communities experiences added complications from increased layers of jurisdiction, lower plant and animal diversity, limited funding, increased public demand to participate in wildlife managing activities, and limited acceptance by academic and governmental organizations (Adams & Lindsey, 2010). Wildlife management and education in urban environments are therefore crucial to increase public understanding of the environment and cause citizens to make more sustainable and wildlife-friendly decisions in their daily lives. Urban wildlife management is an emerging field of ecology that addresses human perspectives as well as wildlife needs in urban ecosystems.

Table 1.1

Wildlife management comparisons in human-altered urban vs. natural rural habitats. Taken from Adams & Lindsey, 2010.

Urban	Rural
1. Lower diversity of native plant and animal species[1].	1. Higher diversity of native plant and animal species.
2. Fewer sources of state and federal funding for management programs.	2. More sources of state and federal funding for management programs.
3. A new and developing focus for research, management, and education programs.	3. A large and established focus for research, management, and education programs.
4. Layers of jurisdiction increase with proximity to urban centers.	4. Layers of jurisdiction decrease with distance from urban centers.
5. Small scales of analysis with many legal and physical impediments in highly fragmented landscapes.	5. Large scales of analysis with few legal and physical impediments in less fragmented landscapes.
6. Requires extensive training and experience in the human dimensions of wildlife management[2].	6. Requires less training and experience in the human dimensions of wildlife management[2].
7. Limited academic and agency acceptance and participation.	7. Wide academic and agency acceptance and participation.
8. Residents have a more heterogeneous set of attitudes and expectations related to wildlife.	8. Residents have a more homogeneous set of attitudes and expectations related to wildlife.
9. Higher public demand for inclusion in the management process.	9. Lower public demand for inclusion in the management process.
10. Higher potential for threat to public health from zoonotic disease and parasites.	10. Lower potential for threat to public health from zoonotic disease and parasites.
11. Management to reduce artificially abundant wildlife populations.	11. Management to sustain artificially abundant wildlife populations.
12. Growing trend toward privatization and commercialization of wildlife management.	12. Majority of management efforts coordinated through state or Federal agencies.
13. Exaggerated time frame for completion of management activities	13. Significantly shorter time frame for completion of management activities
14. Managers may not have required training in wildlife management	14. Managers have required training in wildlife management

[1] deals primarily with a few species that are highly adaptable or fortuitously well-suited to an urban environment.

[2] includes conflict resolution; awareness of public attitudes, activities, knowledge, and expectations; public education; and identification and inclusion of all stakeholder groups.

Wildlife biologists and researchers working in urban environments can provide management information needed by legislative bodies and citizens to assist them in making informed decisions regarding wildlife (Conover, 2002). This can lead to better control of nuisance species, a reduction of human-wildlife conflict caused by misunderstandings of wildlife, and more efficient management and conservation of natural resources. Urban wildlife management can promote biodiversity of native species and addresses the process of managing threatened or endangered species. Taking advantage of the wealth, numbers, and political influence of humans associated with the urban environment, a more environmentally literate urban population could greatly support the conservation of species in both urban and rural ecosystems (McKinney, 2002).

1.7. History of urban wildlife management in the U.S.

Scientists and managers have had a passing interest in the concept of urban wildlife management since the early 1900s, when literature was first published concerning the creation of artificial habitat elements (feeding stations, water sources, and nest boxes) and the manipulation of vegetation to attract wildlife to urban settings (DeStefano & DeGraaf, 2003). However, urban wildlife management did not begin to become a popular aspect of ecology until the 1960s and 1970s, when individuals such as Raymond Dasmann began to make the distinction between old conservation and new conservation (Adams, 2005). Old conservation was focused on natural resource quality, whereas new conservation emphasized open areas, recreation, and quality of the human

environment in urban ecosystems (Adams, 2005). Although traditional wildlife biology focused on researching areas outside the realm of human influence (National parks or wilderness areas), increasing urbanization and subsequent human contact with wildlife demonstrated a need and interest for research regarding urban wildlife (DeStefano & DeGraaf, 2003).

The National Institute for Urban Wildlife, founded in 1973, became a key player in establishing a professional awareness of the need for managing urban wildlife (Adams & Dove, 1989). The National Wildlife Federation also initiated its involvement with urban wildlife conservation with the creation of the Backyard Wildlife Habitat Program in 1973 (Adams, 2005). The Urban Wildlife Committee emerged in the mid-1970s, which later evolved into the Urban Wildlife Working Group of The Wildlife Society and has been one of the most influential organizations in coordinating urban research, workshops, and producing reports (Adams, 2005). In 1983, the U.S. Fish and Wildlife Service was the first federal program to include an urban wildlife program, and six state wildlife agencies reported having an urban program (Lyons & Leedy, 1984).

As human-wildlife interactions and the proliferation of nuisance species amplified in the 1990s, the need for urban wildlife management became clearer. Urban wildlife management typically encompasses a variety of tasks and focuses including animal damage control, educational programs, establishing urban wildlife habitats, urban wildlife research, and working with the local communities and developers. Unfortunately, the evident need for urban wildlife management has still not translated into a solid infrastructure of urban wildlife management from universities, state

departments of natural resources (hereafter DNRs), federal resource management organizations, and other research and management institutions.

1.8. Defining infrastructure

Merriam-Webster defines infrastructure as "the underlying foundation, basic framework, or resources required for an activity." Infrastructure in U.S. policy described the adequacy of the nation's public works such as roads, bridges, airports, schools, and health facilities (Moteff, 2004). Increasing international terrorism in the 1990s caused the Bush administration to revisit the subject of infrastructure in order to provide clear structure and prioritize key assets for protection (Moteff, 2004). This resulted in a new definition of infrastructure: "The framework of interdependent networks and systems comprising identifiable industries, institutions (including people and procedures), and distribution capabilities that provide a reliable flow of products and services essential to the defense and economic security of the United States, the smooth functioning of government at all levels, and society as a whole" (Executive Order 14010, 1996). A clear infrastructure is necessary in order to establish priorities for a more smoothly functioning organization and provide a more reliable production of services.

This concept applies to organizations across a broad range of scales, including the federal government, universities, incident response teams, families, companies, and hospitals. Without proper infrastructure and clarification of priorities, stated goals will not be met, and products of low quality may be produced or not produced at all. In the same manner, infrastructure and defined priorities become necessities in wildlife

institutions to produce services and products the public needs. Urban wildlife management should become clear priority for wildlife institutions along with the infrastructure that can support that need.

1.9. The role of universities and DNRs in managing wildlife

Some of the first wildlife laws in the U.S. regarded ownership of wildlife between individuals, states, and the federal government (as opposed to the European tradition of landowner ownership of wildlife; Lueck, 1989). During the 1800s states began to exert their control over public ownership of wildlife by establishing game seasons, enforcing hunting, fishing, and trapping laws, controlling use of firearms and strategies for hunting animals, and setting daily and seasonal bag limits (Lueck, 1989). State regulation of wildlife is still predominant throughout the U.S., and as a result, state wildlife agencies or DNRs have become the main entity for managing wildlife resources within each state (Jacobson & Decker, 2006).

Federal agencies are involved in managing natural resources including the USFWS, the U.S. Department of Agriculture (USDA), the U.S. Forest Service (USFS), the National Park Service, the U.S. Army Corps of Engineers, and non-governmental organizations (see Table 1.2). Despite the many state and federal agencies that manage natural resources, state wildlife agencies are responsible for the majority of wildlife species (see Table 1.3). Within each state, DNRs have become the principal entities for managing and regulating wildlife and natural resources.

Table 1.2
State and federal agencies involved in wildlife management in the U.S. Taken from Adams & Lindsey, 2010.

Agency	Involvement
USFWS	Protects and enhances fish and wildlife resources for the benefit of the American people and enforces federal wildlife laws.
Bureau of Land Management (BLM)	Manage 262 million surface acres of land to sustain the health of public lands for present and future generations.
National Park Service (NPS)	Regulate use of national parks and provide for environmental enjoyment of the public.
U.S. Geological Survey (USGS)	Study biological resources of the public domain.
Department of Agriculture (USDA)	Includes the Forest Service and Wildlife Services, both which manage wildlife resources (including in urban areas).
State wildlife agencies	Manage state wildlife resources by establishing game seasons, enforcing hunting laws, setting bag limits.

Table 1.3

Levels of government regulation for various wildlife species in the United States. Taken from Lueck, 1989.

GOVERNMENT CONTROL OF VARIOUS SPECIES IN THE UNITED STATES

SPECIES	HABITAT	REGULATOR*			
		P	*S*	*F*	*I*
Ground squirrel	Local	X	X		
Muskrat	Local	X	X		
Porcupine	Local		X		
Wild hogs	Local	X	X		
Beaver	Local		X		
Turkey	Local		X		
Grouse	Local		X		
Quail	Local		X		
Partridge	Local		X		
Fox	Local		X		
Coyote	Local	X	X		
Deer	Local, seasonal moves		X		
Mountain goat	Local, seasonal moves		X		
Bighorn sheep	Local, seasonal moves		X		
Antelope	Local, seasonal moves		X		
Elk	Local, seasonal moves		X		
Trout	Local		X		
Black bear	Local		X		
Grizzly bear	Local		X	X	
Bison	Local, nomadic		X	X	
Eagles	Local, migratory			X	
Walrus	Migratory, polar icepack			X	
Polar bear	Nomadic, polar icepack			X	X
Halibut	Ocean territory			X	X
Salmon	Migratory, local		X	X	X
Fur seals	Ocean territory			X	X
Whales	Ocean, migratory			X	X
Ducks	Continental migrator			X	X
Geese	Continental migrator			X	X

SOURCES.—Michael J. Bean, The Evolution of Wildlife Law (1983); various state wildlife agencies; U.S. Fish and Wildlife Service.

* Regulator: *P* = private; *S* = state; *F* = federal; *I* = international.

Universities play a crucial role in educating and training present and future wildlife professionals and also perform essential research functions. Students trained at universities will become the next generation of biologists to build and sustain an infrastructure for urban wildlife management, both at state DNRs and universities. An earlier survey of fisheries and wildlife professionals indicated that the fish and wildlife courses in their university education provided guidance in performing job duties as future professionals (Adelman, Schmidly, & Cohen, 1994). Because of this, the study

concluded that universities exert considerable influence on the direction of the wildlife profession through their academic programs (Adelman et al., 1994). Therefore, if urban wildlife management is going to become a dominant focus of future wildlife management, universities must conduct research and teach classes on urban wildlife in order to prepare the next generation of wildlife professionals.

1.10. Assessing urban wildlife infrastructure

Just as there are many different stakeholders in wildlife management, there are numerous organizations and entities that play a role in managing urban wildlife. Each entity plays an essential part in developing the demand and structure for urban wildlife management (Figure 1.1). Stakeholders involved in urban wildlife management include state wildlife agencies, universities, federal organizations (Table 1.1), animal rehabilitation facilities, animal damage control, urban residents, municipal governments, and news media. The products and beliefs produced by these stakeholders are all interrelated and inter-dependent. A wheel symbolizes the importance of each of these components: a missing spoke or section of the wheel results in a dysfunctional system. Because universities and state wildlife agencies are two of the main driving forces for wildlife management, they are also two of the main components of a successful system for urban wildlife management. Therefore, our assessment of DNRs and universities helped determine part of the structure for urban wildlife management and provided insight for strengthening these two portions of the wheel.

Figure 1.1. Some stakeholders involved with and contributions to urban wildlife management. Each stakeholder is akin to a portion or spoke of a wheel; without each section or spoke the wheel does not function properly.

1.11 Assessing urban wildlife management in DNRs and universities

The focus on urban wildlife management in DNRs and universities can be assessed by funding levels and sources, number of professional wildlife biologists focused solely on urban wildlife management, numbers and types of research and publications on urban wildlife, and types of pre- and in-service training for personnel. When these various metrics were used to gauge support for urban wildlife management

in the U.S., it became clear that academic institutions and state DNRs have not begun to emphasize urban wildlife management within their agency.

In the early 1980s, approximately 2% of wildlife research budgets at universities were devoted to urban wildlife (Adams, Leedy, & McComb, 1987). Though rates of urban wildlife research and publications have been increasing, urban wildlife publications still account for less than 2% of the publication volume of animal behavior, ecology, and wildlife biology journals (Magle, Hunt, Vernon, & Crooks, 2012). Only 7 land-grant universities offering degrees in wildlife sciences also provided at least one course in urban wildlife management (Adams, 2003). This study showed that the support and structure for urban wildlife management at universities could not be clearly articulated, and state DNRs were ill-equipped to deal with the increasing need for urban wildlife management within their states. For example, a survey in 1999 showed that less than 1% of wildlife biologists employed at state DNRs were devoted solely to urban wildlife (Adams, 2003). Urban wildlife biologists employed by state DNRs had few qualifications (if any) that separated them from other wildlife biologists, even though they are more likely to encounter human-wildlife conflicts, wildlife damage problems, and the effect of urbanization on natural habitats during their careers (Adams, 2003). Only 14 states addressed urban wildlife issues in 1983, which increased to only 24 states in 2000 (Adams, 2005).

Given the growth of urbanization in the U.S., the increasing human disconnect from the environment, and the drastic effect urbanization has on wildlife, it is crucial that universities and state DNRs provide a reliable foundation for urban wildlife

management in society. Without an infrastructure for urban wildlife management provided by universities and state DNRs, the nation will continue to experience increasing human-wildlife conflicts, environmental illiteracy, overpopulation of urban areas by nuisance wildlife species, and human disconnect from the environment. Universities and state DNRs are the main driving forces for research and management, and it is crucial that these institutions provide support for managing wildlife in urban environments.

This study was conducted on a national level to determine the degree to which an infrastructure and support for urban wildlife management in the U.S. existed within state DNRs and universities. The objectives of this study were: 1) to assess whether a structure for urban wildlife management at state DNRs and universities across the U.S. existed; 2) compare current infrastructure for urban wildlife management to the infrastructure present prior to 2000; and 3) determine how current infrastructure for urban wildlife management might be related to other national trends including level of urbanization, economic loss due to urban wildlife, and participation in wildlife-related activities.

2. METHODS

2.1. Survey administration

This study focused on the university and DNR portions of the infrastructure for urban wildlife management model (Figure 1.1). Questionnaires were sent to all state DNRs and universities that offer a Bachelor's Degree in Wildlife Science and/or a minimum of 10 wildlife courses. This survey was conducted in the same fashion to a similar study conducted in 1999, which allowed for basic comparisons and evaluation of the progress of urban wildlife management in the last decade (Adams, 2003). Surveys were pre-tested by individuals at Texas Parks and Wildlife Department, Texas A&M University, and Virginia Tech. An online survey was conducted using Survey Monkey to institutions (universities and DNRs) across all 50 states to determine the status of urban wildlife management in each state (Adams, 2003).

Calls were made to each institution prior to releasing the questionnaire to determine which individual would be most appropriate to respond. It was not unusual to conduct several telephone interviews to identify the most informed individual on urban wildlife management in a state. In addition, to confirm potential university respondents, online research interests for university faculty members were reviewed. Respondents were asked leading questions to determine their qualifications and knowledge regarding urban wildlife management in their state. Respondents were asked whether they were familiar with urban wildlife management issues in their state, what was the largest urban wildlife management issue in their state, and their role in managing urban wildlife. If the

respondent was unable to answer questions about urban wildlife in their state, they were asked to recommend another individual within their institution who might be more appropriate to respond. If multiple universities within each state met the selection criteria, responses were collected from one participant from each university. If multiple responses were received from a DNR, based on job position and answers to leading questions, only the most informed individual's response was used in analyses.

After releasing the online questionnaire to the appropriate individual, follow-up procedures were conducted if it was not completed and returned within two weeks. Follow-up consisted of multiple reminder emails and phone calls. University respondents were more difficult to contact through phone, so after leaving two messages, potential respondents were emailed an introduction to the questionnaire. If the respondent did not respond after two weeks, another contact within the department was pursued. In total, individuals were permitted two months to complete questionnaires from the first contact attempt.

If an individual declined the opportunity to participate in the study, they were requested to direct the questionnaire to an individual within the same institution who was equally qualified and might be willing to participate. After allowing the selected participants ample time to complete the questions and multiple reminder phone calls and emails, responses were compiled and analyzed. All questionnaires were associated with the respondent's state rather than the respondent's personal identity. Texas A&M University's Institutional Review Board (Protocol Number 2013 – 0813) approved all research methods and the questionnaires.

Results were analyzed using descriptive statistics and chi-squared tests (comparison with a 1999 data set). Additional data including percent of population in urban areas, percent of public involved in wildlife watching activities, and human-wildlife damage trends from other nation-wide data sets were then considered in further analyses to determine whether any of these variables would predict the existence of urban wildlife management infrastructure at either state universities or wildlife agencies.

In each state the percent of the population living in urban areas was provided by the 2010 national census (U.S. Census Bureau, 2010). The levels of public involvement in wildlife watching activities came from the 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (U.S. Department of the Interior et al., 2011). Data were indicated as a percentage of individuals from that state who participated in wildlife watching activities (it did not take into account days spent on activities). Robert Meyers, an IT Staff Officer from U.S. Department of Agriculture-Animal and Plant Health Inspection Service (USDA-APHIS)-Wildlife Services, provided data describing monetary loss due to wildlife damage in urban areas. These monetary estimates came from sources normally associated with urban wildlife damage, but these losses may not have occurred solely in urban areas since no subdivision between urban and rural environments was made when recording these data (R. Meyers, personal communication, April 21, 2014). Additionally, these data were from estimates and may not have represented all states equally because not all states may have recorded values for all damage categories. Damage values were divided by number of residents in urban areas for that state to provide an approximate value of per capita economic loss. Damage

values from 2010 were used in order to be consistent with the census data and U.S. Department of the Interior et al. (2011), which was also based on the 2010 census data.

Several tests of the degree of association between selected variables were conducted to determine how they might predict the existence of an infrastructure for urban wildlife management in each state. Dependent variables were taken from survey questions on involvement in urban wildlife management concerns, relative number of urban wildlife biologists, proportion of wildlife personnel devoted solely to urban wildlife, and frequency of urban wildlife publications. These variables were correlated with independent variables including percent of population in urban areas, public involvement in wildlife watching activities, and economic loss due to animal damage in urban areas.

Logistic regression models were created individually to predict institution involvement, relative number of urban wildlife biologists, and frequency of urban wildlife publications as a function of percent urban population, public involvement, and economic loss (Appendix A). The number of urban wildlife biologists for each institution (universities and DNRs) was divided into three categories: 1) zero, 2) one, or 3) more than one urban wildlife biologist. The frequency of publications was divided into three categories from a question asking how frequently institutions public literature on urban wildlife including: 1) not at all, 2) occasionally, or 3) frequently. Linear regression models were used to predict the relative number of urban wildlife biologists within an institution as a function of percent urban population, public involvement, and economic loss.

The stepwise fit model function in JMP Pro 11 was used to create models that were then evaluated using the Akaike information criterion (AIC; Akaike, 1973). Models with $\Delta AIC < 2$ that had comparable number of parameters were considered to be competitive models (Burnham & Anderson, 2002; Arnold, 2010). The AIC*w* indicated the weight of evidence in favor of the model given the set of candidate models. All analyses were conducted in JMP ® Pro 11.0.0, and differences were considered statistically different when $P < 0.05$.

2.2. Survey content

Each questionnaire (Appendices B and C) consisted of 18 questions and was expected to take no longer than 25 minutes to answer. Questions examined:

1. relevant urban wildlife management issues
2. number of wildlife biologists
3. number of urban wildlife biologists
4. qualifications and tasks that differentiate urban from other wildlife biologists
5. degree of respondent (university or state agency) responsibility for urban wildlife management
6. how urban wildlife management issues are addressed
7. the need for urban wildlife management
8. the proportion of urban wildlife research conducted within the institution, and
9. problematic and nuisance species within each state

It became evident during the respondent invitation process that many states did not have full time urban wildlife biologists, yet many of their employees were involved in urban wildlife-related tasks. University respondents were asked what urban wildlife-related tasks their faculty accomplished at their institution. This permitted an assessment of what urban wildlife-related tasks were being accomplished despite the small number of urban wildlife biologists across the nation.

Because of the importance of student training, university and DNR respondents were asked to identify the wildlife and urban wildlife programs at universities and colleges within their states. Chi-square tests determined the differences in responses with a 1999 study (Adams, 2003).

2.3. Study limitations

Unfortunately, there were many unforeseen circumstances that proved to be obstacles during the duration of this study. One of the main concerns was communicating with the right individual. Often potential respondents would recommend other individuals to contact because they were limited by time or did not feel they would be able to adequately answer all the questions. In addition, some states that had multiple individuals who were capable of answering the questionnaire, whereas other states only had one qualified individual. Finding the correct individual and encouraging participation in the study often required numerous phone calls, leaving messages, and sending emails to various individuals.

Contacting university personnel proved to be a great challenge. Despite the number of times respondents were called, left messages, and emailed, there were many university personnel that did not respond. This was likely due to the significant amount of time that university faculty spend either teaching or conducting research away from their offices, or lack of interest in the study overall.

Despite the extensive survey reviewing process prior to administering the questionnaire, there were still complications with various interpretations of survey questions. Respondents communicated these interpretations by leaving comments about the question online, emailing suggestions, and calling to clarify or confirm what they believed the question was asking. From these communications one question was removed from the analyses in order to prevent misinterpretation of responses (refer to question 14 in Appendix B).

Lastly, the DNR questionnaire was pre-tested using DNR personnel employed by the Texas Parks and Wildlife Department (TPWD). While speaking with individuals in DNRs across the nation, it became clear that TPWD is structured differently from the majority of other states and Texas is one of the few states that has a designated urban wildlife program.

3. RESULTS

3.1. DNR results

Sixty-four questionnaires were received from DNR employees, with at least one response from each state (questions sent to DNRs are listed in Appendix C; DNRs involved in the study are listed in Appendix D). For states that had multiple survey responses, one respondent with the most experience, qualifications, and ability to answer leading questions about urban wildlife management was selected. Respondents were determined to be most qualified based on responses to questions about urban wildlife management as well as their job position within the agency. Additional responses were removed from further analyses.

Across the entire nation, approximately 7,385 employees within state DNRs possessed a Bachelor's degree (B.S.) in wildlife or biological sciences when hired (n = 41 states). On average, this was an increase from the number of employees that were required to have a B.S. degree for employment in 1999 (Figure 3.1). An *urban wildlife biologist* was defined as an individual who works or conducts research primarily in urbanized environments with a focus on non-domestic vertebrate and invertebrate species as well as human associations with wildlife (including education and conflict resolution). According to this definition, a total of 93 (average 1.9 per state with 95% CI [0.74, 3.05]) urban wildlife biologists were employed by DNRs across the nation (Figure 3.1, n = 49). New Jersey was excluded from this count because the respondent considered all 200 biologists employed by New Jersey Fish & Wildlife to be urban

wildlife biologists without the associated job title. New Jersey was included as a state with urban wildlife biologists in other questions involving tasks and qualifications of urban wildlife biologists. The maximum number of urban wildlife biologists employed by a single state was 9 in 1999, which increased to 18 in 2014. However in 2014, 33 states still did not have a single urban wildlife biologist employed by their agency. Respondents (n = 47) estimated that 139 (average 2.6 per state with 95% CI [1.88, 3.95]) urban wildlife biologists would be needed across the nation to address urban wildlife management concerns in their states. This estimate was lower than the 1999 estimate (Figure 3.1).

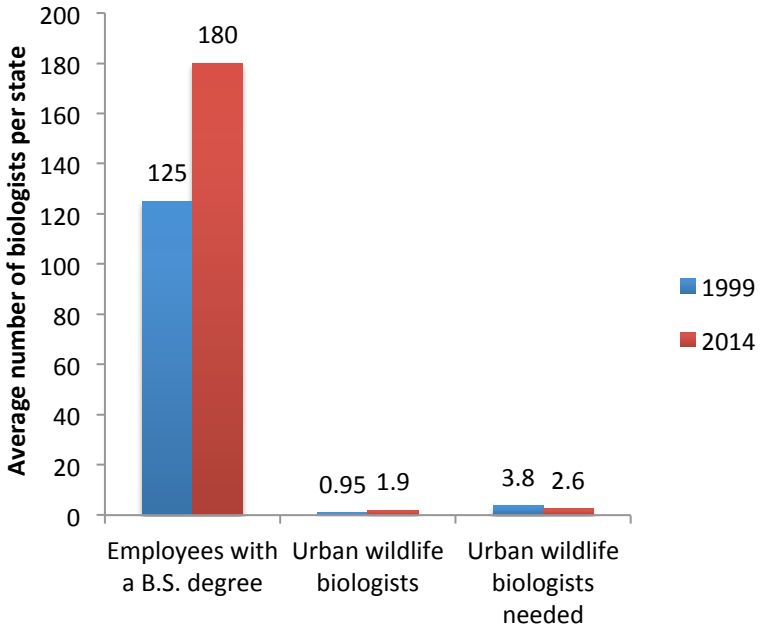

Figure 3.1. Average number of urban wildlife biologists on staff and needed compared to the number of state wildlife agency employees with a B.S. degree in 1999 (n = 46) and 2014 (n = 50). Refer to questions 3, 8, and 9 in survey (Appendix C).

Urban wildlife management issues were a concern in every state. The most prevalent concern (94%) across the nation was that urban residents needed educational programs about the wildlife around them (Table 3.1). There was no significant difference in response frequencies (90%, $p = 0.84$) when compared to the 1999 study (Adams, 2003). Eighty-six percent of the 2014 respondents agreed that urban wildlife management was a growing concern in natural resource management compared to the 85% in 1999 ($p = 0.84$). Additionally, 84% and 83% respondents reported in 2014 and 1999, respectively, that several species were increasing to nuisance levels in urban communities ($p = 0.85$). There was also growing concern about human-wildlife encounters in urban areas (84%), which was an increase from 69% of respondents that reported a concern in 1999 ($p = 0.02$). Despite the growing concern regarding human-wildlife encounters, a smaller percentage (50%) of DNRs believed that there was a growing curiosity about wildlife when compared to 1999 (67%, $p = 0.01$)

Table 3.1.
Statements regarding urban wildlife management concerns that were relevant to state wildlife agencies in 1999 (Adams, 2003; $n = 46$) and 2014 ($n = 50$).

Statement regarding relevant urban wildlife management concerns	Percent agreed 1999	Percent agreed 2014	Chi square	*p*
Urban wildlife management is a growing concern	85%	86%	0.04	0.84
Urban wildlife management will become the dominant future focus in this state	10%	20%	5.56	0.02
Several species of wildlife are increasing to nuisance levels	83%	84%	0.04	0.85
There is a growing curiosity about wildlife	67%	50%	6.54	0.01
There is a growing concern about human-wildlife encounters	69%	84%	5.26	0.02
People living in urban communities need educational programs	90%	94%	0.89	0.34

Note. Refer to question 4 in survey (Appendix C).

The majority (80%) of the DNR respondents agreed that there was a strong public demand for urban wildlife management in their state. However, only 20% believed that urban wildlife management would become the dominant future focus in their state (Table 3.1), and 50% believed there were not enough trained and equipped biologists to handle urban wildlife management issues.

The majority (88%) of respondents agreed and 12% were undecided or disagreed that their agency was involved in urban wildlife management concerns ($n = 50$). When asked how urban wildlife management issues were addressed in their state, 22% identified their urban wildlife biologists, which did not differ from the 25% reported in 1999 (Table 3.2, $p = 0.62$). However the majority (92% and 94%) of 2014 and 1999 respondents, respectively, used their existing field wildlife biologists to address urban wildlife management concerns ($p = 0.57$). In addition to addressing concerns themselves, 32% of 2014 respondents acknowledged that management concerns in their state are also the responsibility of private organizations, which has increased from the 19% reported in 1999 ($p = 0.02$). Only a small percentage (6%) of 2014 respondents and 19% of 1999 respondents agreed that other state agencies handled many of the urban wildlife management issues in their state ($p = 0.02$). Respondents identified other wildlife programs that also addressed urban wildlife management issues including: local animal control, volunteers from Master Wildlife Conservationist Programs, law enforcement, USDA Wildlife Services, and city governments.

Table 3.2.
State wildlife agency respondents' views of how urban wildlife management issues are addressed in their state, both in 1999 (n = 46) and 2014 (n = 50).

Method	Percent agreed 1999	Percent agreed 2014	Chi square	*p*
Handled by our urban wildlife biologists	25%	22%	0.24	0.62
Responsibility of another state agency	19%	6%	5.49	0.02
Use existing wildlife biologists	94%	92%	0.32	0.57
Responsibility of private organizations	19%	32%	5.49	0.02

Note. Refer to question 6 in survey (Appendix C)

Respondents were asked what qualifications differentiated an urban wildlife biologist from other biologists in their agency. Of the 17 states that have urban wildlife biologists, some of the most common qualifications included 1) being able to integrate wildlife management concerns into urban development and landscape design (44%); 2) the ability to identify characteristics, life histories, and habitat requirements of visible urban wildlife species (47%); 3) being willing and able to be interviewed by mass media (47%); 4) understanding how municipal, county, state, and federal governments work (59%); and 4) being willing and able to handle and solve urban wildlife damage and nuisance complaints (41%, Table 3.3). Forty-one percent of respondents noted that there are no qualifications that differentiated urban wildlife biologists from other wildlife biologists in their agency. One out of 17 respondents noted that urban wildlife biologists in their state did not need a B.S. degree in wildlife or biological sciences to be employed.

Table 3.3.
Qualifications that differentiated urban wildlife biologists from other wildlife biologists at state wildlife agencies (n = 17) in 2014.

Qualification	Percent who agreed
Be able to integrate wildlife management concerns into urban development and landscape design	47%
Be able to recognize and evaluate the effects of urbanization on habitat	35%
Know identifying characteristics, life histories, and habitat requirements of visible urban species	47%
Be able to identify and explain wildlife utilization of native flora and cultivated plant species	29%
Have a working knowledge of nature interpretation	18%
Be willing and able to be interviewed by mass media	47%
Understand how municipal, county, state, and Federal governments work	59%
Have a basic understanding of environmental laws and regulations	35%
Be willing and able to handle urban wildlife damage complaints	41%
Be able to evaluate public attitudes and expectations concerning urban wildlife	35%
Does not need a B.S. degree in wildlife or biological sciences	6%
There are no qualifications that differentiate urban wildlife biologists from other wildlife biologists	41%

Note. Refer to question 10 in survey (Appendix C).

Tasks that differentiated urban wildlife biologists from other state biologists included: 1) conducting community educational programs about urban wildlife (59%); 2) producing publications about urban wildlife (47%); 3) furnishing urban ecosystem management information to the public (47%); 4) working with local government in urban planning (69%); and 5) working with urban community groups (53%, Table 3.4). Twenty-four percent of states that had urban wildlife biologists noted that there were no tasks or duties that differentiated urban wildlife biologists from other wildlife biologists in their state (Table 4). Many states replied that they did not have urban wildlife

biologists or their other field biologists were partially responsible for accomplishing these tasks.

Table 3.4.
Tasks and duties that differentiated urban wildlife biologists from other wildlife biologists at state wildlife agencies (n = 17) in 2014.

Task required	Percentage who agreed
Animal damage control	41%
Operate urban nature centers	0%
Organize urban youth hunts	24%
Establish urban wildlife habitats	24%
Produce urban wildlife publications	47%
Offer school programs on urban wildlife	35%
Conduct urban wildlife management research	35%
Conduct educational programs about urban wildlife	59%
Furnish urban ecosystem management information to the public	47%
Work with local government in urban planning	71%
Work with urban community groups	53%
Work with developers	29%
There are no tasks that differentiate urban wildlife biologists	24%

Note. Refer to question 11 in survey (Appendix C).

In order to determine the focus of research efforts at state agencies, respondents were asked how often they produced publications on game species, non-game species, and urban wildlife species. Respondents produced publications on game species and non-game species more frequently than they produced publications on urban wildlife species (Figure 3.2). Publications on urban wildlife species were produced only occasionally (72%) or not at all (18%). Most respondents produced publications on game species frequently (68%) but only 10% of respondents produced literature on urban wildlife on a frequent basis (Figure 3.2).

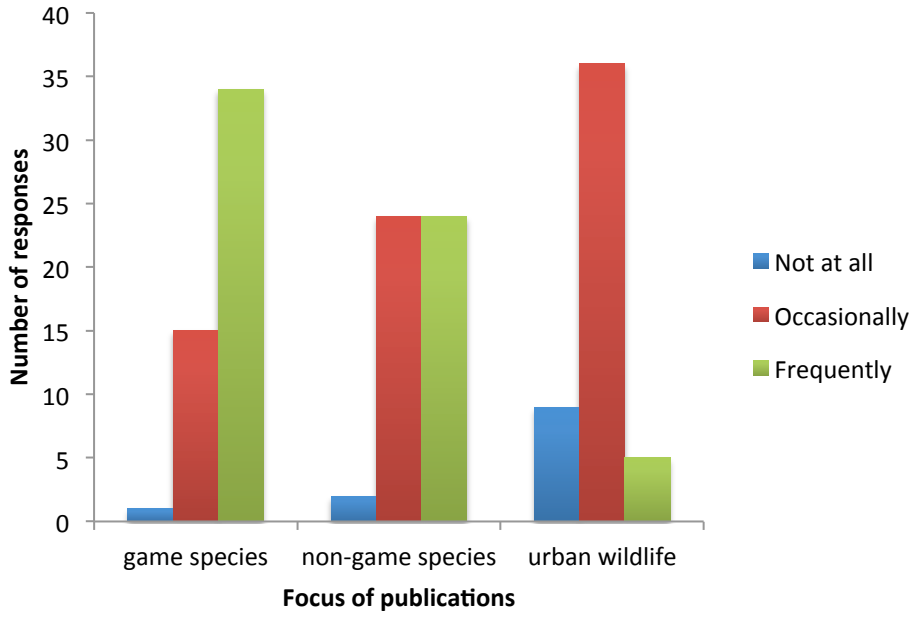

Figure 3.2. Frequency of publications on game species, non-game species, and urban wildlife species at state wildlife agencies across the nation (n = 50) in 2014. Refer to question 13 in survey (Appendix C).

Respondents were asked how urban wildlife management was funded within their state. Main sources for funding included Pittman-Robertson (PR) funds (36%) or license sales (48%, Table 3.5). The 1938 Pittman-Robertson Federal Aid in Wildlife Restoration Act directed an excise tax on firearms and ammunition towards wildlife conservation (16 U.S.C. 669-669I), which is where states have traditionally received their funding from. Thirty-two percent of respondents reported there were no funding sources for urban wildlife management concerns within their state. Additional sources of funding included non-game permits, donations, personalized license plate sales, and state general funds. A larger proportion of states that had urban wildlife biologists received funding from PR, license sales, non-game permits, and state general funds than did states

without urban wildlife biologists (Table 3.6). Respondents also commented that they did not have a specific urban wildlife program, and therefore urban wildlife activities were integrated into their standard operation and handled by existing staff and budgets.

Table 3.5.
Various funding sources for addressing urban wildlife management issues within state wildlife agencies in 2014. Each respondent could select multiple responses (n = 50).

Funding sources	**Number of responses**
Pittman-Robertson funds	18
License sales	24
Non-game permits	2
Donations	1
Raised by the public	0
Volunteers	1
State general funds	10
No funding sources	16

Note. Refer to question 15 in survey (Appendix C).

Table 3.6.
Differences in funding sources between states without and with urban wildlife biologists in 2014.

Funding Sources	**without** (n=33)	**with** (n=17)
Pittman-Robertson funds	27%	53%
License Sales	45%	53%
Non-game permits	0%	12%
Donations	3%	0%
Raised by the public	0%	0%
Volunteers	0%	6%
State general funds	18%	24%
No funding sources	39%	18%

State DNRs were also asked what limitations prevented greater emphasis on urban wildlife management within their agency. The majority of respondents agreed that limited funding prevents further emphasis in their state (76%, Figure 3.3). Most states also noted that a lack of urban wildlife biologists prevented the development of urban wildlife management in their state (52%, Figure 3.3). Other limitations included public opposition, opposition within the agency, a view that urban wildlife management was not scientific, and the prevalence of other more important wildlife issues to address. Ten percent of states believed that nothing limited involvement in urban wildlife management in their agency. One respondent commented that the "biggest obstacle to greater emphasis on urban wildlife management issues was limited funding and the inability to employ full time staff devoted to urban issues." Other respondents noted that having a directed urban wildlife program was a low priority, and urban wildlife management was not considered necessary or important by senior leadership or elected officials.

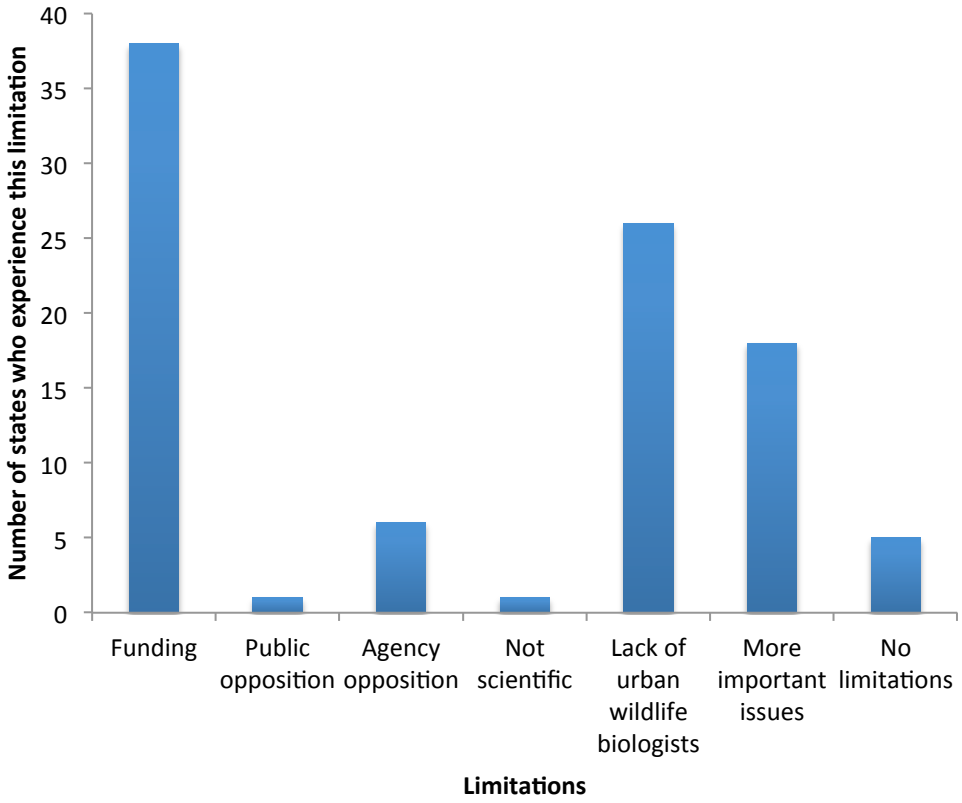

Figure 3.3. Limitations that prevented a greater emphasis on urban wildlife management within state agencies in 2014. Multiple responses were allowed (n = 50). Refer to question 16 in survey (Appendix C).

3.2. University results

Seventy-three out of 81 universities (90%) across the nation responded to the invitation to participate in this study (respondents' universities are listed in Appendix E). Some states had multiple universities that met the selection criteria. Four states (Connecticut, Mississippi, New Jersey, and Rhode Island) were not represented in the study because the selected universities from those states did not participate in this study, or they did not have a university that met the selection criteria.

There were 1,066 employees required to have a PhD in wildlife or biological sciences when hired (n = 72 responses), compared to 545 reported in 1999 (Figure 3.4). According to the definition of an urban wildlife biologist given earlier, 33 (average 0.43 per university with 95% CI [0.25, 0.67]) full time urban wildlife biologists were employed by the universities included in this study (Figure 3.4, n = 72). The maximum number of urban wildlife biologists employed by a single university was 2 in 1999, which increased to 6 in 2014. However the majority (67%) of respondents still did not have any urban wildlife biologists employed by their university. Respondents (n = 71) estimated that a total of 73 (average approximately one per university with 95% CI [0.79, 1.27]) urban wildlife biologists would be needed in order to address urban wildlife management concerns (Figure 3.4).

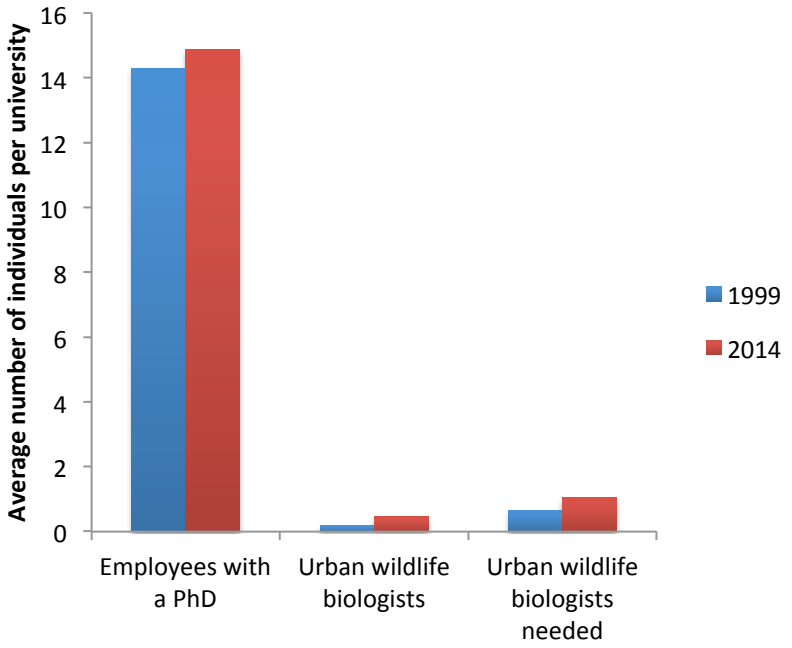

Figure 3.4. Average number of urban wildlife biologists on staff and needed compared to the number of university employees with a PhD in 1999 (n = 37) and 2014. Refer to questions 3, 8, and 9 in survey (Appendix B).

Urban wildlife management issues were a concern for every respondent. The most prevalent concern (85%) across the nation was that several species of wildlife were increasing to nuisance levels in urban communities (Table 3.7). This differs in response frequency (60%, $p < 0.01$) when compared to a 1999 study (Adams 2003). Seventy-eight percent and 86% of respondents agreed in 2014 and 1999, respectively, that urban wildlife management was a growing concern in natural resource management ($p = 0.05$). Seventy-eight percent of 2014 respondents (compared to 89% in 1999) agreed that people living in urban communities needed educational programs about the wildlife around them ($p = 0.01$, Table 3.7). The majority of 2014 (78%) and 1999 (73%)

respondents agreed that there was a growing concern about human-wildlife encounters in urban areas ($p = 0.21$). A lack of urban wildlife biologists that were trained and equipped to handle urban wildlife management issues was noted by 58% of universities. However despite the prevalence of these urban wildlife management concerns at universities, only 10% of respondents believed that urban wildlife management would become the dominant future focus in their state.

Table 3.7.
Statements regarding urban wildlife management that were relevant to universities in 1999 (Adams, 2003; $n = 37$) and 2014 ($n = 73$).

Statement regarding relevant urban wildlife management concerns	Percent agreed 1999	Percent agreed 2014	Chi square	p
Urban wildlife management is a growing concern	86%	78%	3.80	0.05
Urban wildlife management will become the dominant future focus in this state	11%	10%	0.15	0.70
Several species of wildlife are increasing to nuisance levels	60%	85%	18.91	<0.01
There is a growing curiosity about wildlife	62%	62%	<0.00	0.95
There is a growing concern about human-wildlife encounters	73%	78%	1.54	0.21
People living in urban communities need educational programs	89%	78%	7.11	0.01

Note. Refer to question 4 in survey (Appendix B).

The majority (72%) of the university respondents agreed that there was a strong public demand for urban wildlife management in their state. Additionally 66% of university respondents agreed that their department was involved in urban wildlife management concerns in their state (48 of 73 respondents). A total of 25 respondents were undecided or disagreed that their department was involved in urban wildlife management concerns in their state.

University respondents were asked how urban wildlife management issues were addressed in their state. The majority of respondents in 2014 (70%) and in 1999 (62%), respectively, used their traditional wildlife biologists to address urban wildlife management concerns ($p = 0.17$, Table 3.8). Only 34% of universities used their *urban wildlife biologists* to address urban wildlife issues within their state (differs from 14% in 1999, $p < 0.01$). Universities acknowledged that urban wildlife management concerns were also addressed by other state agencies (41%, differs from 1999, $p < 0.01$) or could be the responsibility of private organizations (37%, not different from 1999, $p = 0.05$). Respondents also commented that urban wildlife issues were often handled through wildlife services, university extension, municipal animal control, humane societies, and state biologists.

Table 3.8.

University respondents' views of how urban wildlife management issues were addressed in their state, both in 1999 (Adams, 2003; $n = 37$) and 2014 ($n = 73$).

Method	Percent agreed 1999	Percent agreed 2014	Chi square	p
Handled by our urban wildlife biologists	14%	34%	24.85	<0.01
Responsibility of another state agency	65%	41%	18.34	<0.01
Use existing wildlife biologists	62%	70%	1.92	0.17
Responsibility of private organizations	27%	37%	3.69	0.05

Note. Refer to question 6 in survey (Appendix B).

Table 3.9.
Qualifications that differentiated urban wildlife biologists from other wildlife biologists at universities (n = 73) in 2014.

Qualification	Percent who agreed
Be able to integrate wildlife management concerns into urban development and landscape design	85%
Be able to recognize and evaluate the effects of urbanization on habitat	88%
Know identifying characteristics, life histories, and habitat requirements of visible urban species	86%
Be able to identify and explain wildlife utilization of native flora and cultivated plant species	62%
Have a working knowledge of nature interpretation	42%
Be willing and able to be interviewed by mass media	71%
Understand how municipal, county, state, and Federal governments work	75%
Have a basic understanding of environmental laws and regulations	74%
Be willing and able to handle urban wildlife damage complaints	51%
Be able to evaluate public attitudes and expectations concerning urban wildlife	77%
Does not need a PhD in wildlife or biological sciences	15%
None of the above	3%

Note. Refer to question 10 in survey (Appendix B).

University respondents reported what qualifications would be required of an urban wildlife biologist in their department (whether or not they currently had an urban wildlife biologists on staff). The most prevalent qualifications included: 1) being able to recognize and evaluate the effects of urbanization on habitat (88%); 2) having the knowledge of identifying characteristics, life histories, and habitat requirements of highly visible urban wildlife species (86%); and 3) being able to integrate wildlife management concerns into urban development and landscape design (85%). Other important qualifications were listed in Table 3.9. Respondents also noted that candidates with a human dimensions background would be a high priority, as well as those with good communication skills. One respondent stated that the list of qualifications was too broad for any single faculty member (Table 3.9).

The primary tasks that departments were involved in included conducting urban wildlife management research (66%) and producing publications about urban wildlife (58%, Table 3.10). Universities reported little involvement with other urban wildlife management tasks and duties except teaching classes on urban wildlife management. One faculty member noted that none of the tasks were actually required of faculty members, but faculty will volunteer for tasks upon request.

Table 3.10.
Tasks and duties related to urban wildlife management that were accomplished by university faculty (n = 73) in 2014.

Task accomplished by faculty	Percent who agreed
Animal damage control	27%
Operate urban nature centers	4%
Organize urban youth hunts	4%
Establish urban wildlife habitats	29%
Produce urban wildlife publications	58%
Offer school programs on urban wildlife	25%
Conduct urban wildlife management research	66%
Conduct educational programs about urban wildlife	48%
Furnish urban ecosystem management information to the public	32%
Work with local government in urban planning	44%
Work with urban community groups	37%
Work with developers	25%
There are no tasks that differentiate urban wildlife biologists	10%

Note. Refer to question 11 in survey (Appendix B).

University respondents were asked about how frequently faculty produced publications on urban wildlife when compared to game and non-game species. The majority of respondents reported that their faculty published literature on game species occasionally (41%) or frequently (59%, Figure 3.5), non-game species either occasionally (26%) or frequently (74%, Figure 3.5), and on urban wildlife only occasionally (72%) or not at all (19%, Figure 3.5). Only 6 university respondents (10%) said they produced urban wildlife literature on a frequent basis.

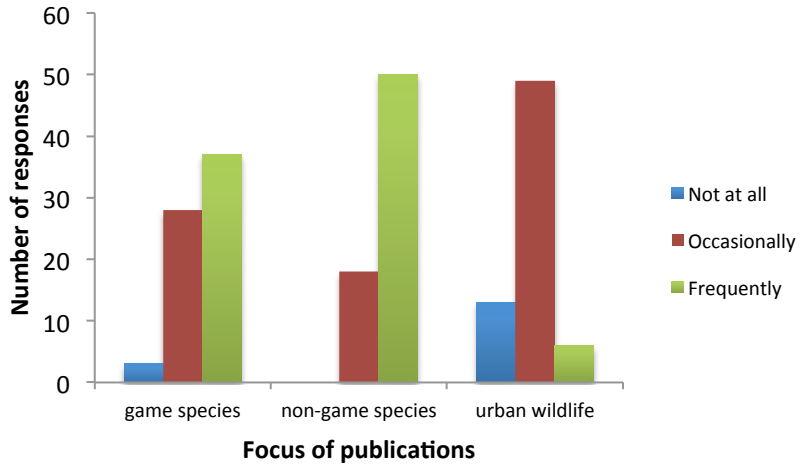

Figure 3.5. Frequency of publications on game species, non-game species, and urban wildlife species at universities across the nation (n = 68) in 2014. Refer to question 13 in survey (Appendix B).

Limited funding was the main restriction (70%) that prevented a greater focus on urban wildlife management and research (Figure 3.6). Other limitations included lack of interest within the department (32%), a lack of researchers (including graduate students) interested in urban wildlife (37%), and the prevalence of other more important wildlife management issues to study (34%). Additionally, faculty commented that a lack of personnel prevented a greater emphasis on urban wildlife, particularly in small departments that did not have the time to teach specialized courses or faculty with an urban wildlife focus. Only twelve university respondents (16%) reported that there was nothing that limited their departmental teaching and research programs on urban wildlife (Figure 3.6).

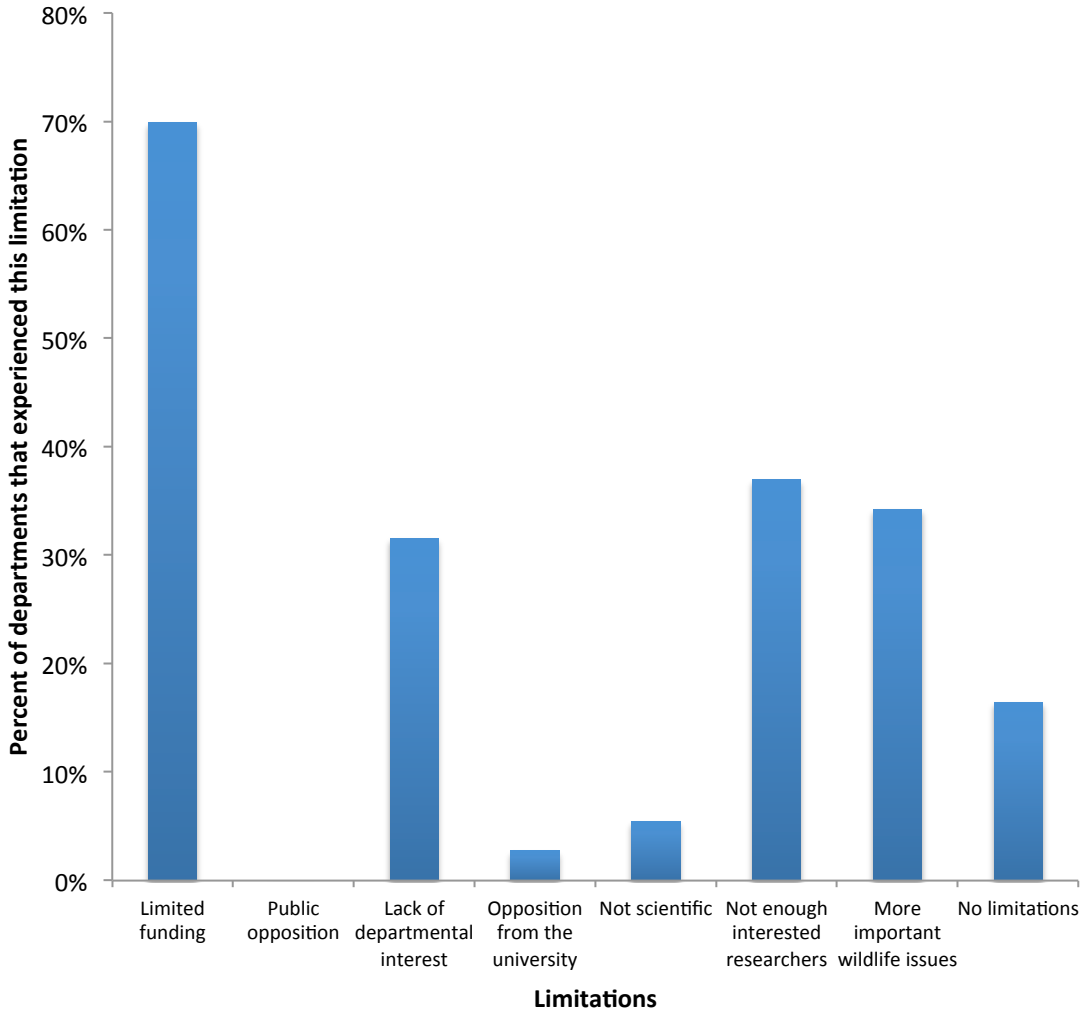

Figure 3.6. Limitations that prevented a greater emphasis on urban wildlife management within universities in 2014. Multiple responses were allowed (n = 73). Refer to question 16 in survey (Appendix B).

3.3. Wildlife programs at universities

It is expected that wildlife programs at universities will provide the structure and personnel for future wildlife management needs nationally. Students trained at universities today will become the next generation of biologists to provide the infrastructure for urban wildlife management, both at state DNRs and universities. University and DNR respondents were asked about details concerning wildlife and urban wildlife programs at universities and colleges within their states and results were compared to what was found in 1999 (Adams, 2003).

Similar to what was found in 1999, universities and DNRs were in close agreement concerning the number of universities or colleges in their state that offered wildlife degrees, wildlife courses, and urban wildlife courses (see Table 3.11). Universities reported an average of 3.15 universities or colleges per state that offered a B.S. degree in wildlife-related sciences, while DNRs reported an average of 3.05 (compared to 1.83 and 1.6 reported for universities and DNRs in 1999). Universities reported an average of 4.45 universities or colleges that offered wildlife courses while DNRs reported an average of 3.89 (compared to 3.03 and 2.17 reported for universities and DNRs, respectively, in 1999). The average number of urban wildlife courses offered at universities or colleges increased from 0.17 in 1999 (for both DNRs and universities) to 0.57 and 0.59 reported in 2014 by universities and DNRs, respectively.

Table 3.11.

Number of universities and colleges within each state that offered wildlife degrees, wildlife courses, and urban wildlife courses according to DNRs and universities in 1999 (Adams, 2003) and in 2014.

	University average 1999	DNR average 1999	University average 2014	DNR average 2014
Offer B.S. degree in wildlife-related sciences	1.83 (n = 35)	1.6 (n = 35)	3.15 (n = 66)	3.05 (n = 41)
Offer courses in wildlife sciences	3.03 (n = 30)	2.17 (n = 28)	4.45 (n = 60)	3.89 (n = 37)
Offer a course in urban wildlife management	0.17 (n = 20)	0.17 (n = 23)	0.57 (n = 58)	0.59 (n = 37)

Note. Refer to question 12 in surveys (Appendix B and C).

3.4. Species of special concern

University and DNR respondents were asked to list species of special concern in their state that were known to cause detrimental economic, human health, or habitat effects in urban communities. Four out of five of the most prevalent species of concern were the same for DNR and university respondents. The five dominant species of concern reported by DNR respondents included geese (88%), white-tailed deer (80%), coyotes (76%), raccoons (76%), and skunks (72%). The five most frequent species of concern across the U.S. reported by 73 university respondents included white-tailed deer (74%), raccoons (73%), feral cats (68%), coyotes (66%), and geese (66%). A closer look at these species of concern showed that DNRs and universities often had different perceptions concerning what species were problematic in their state (See Figures 3.7 – 3.12).

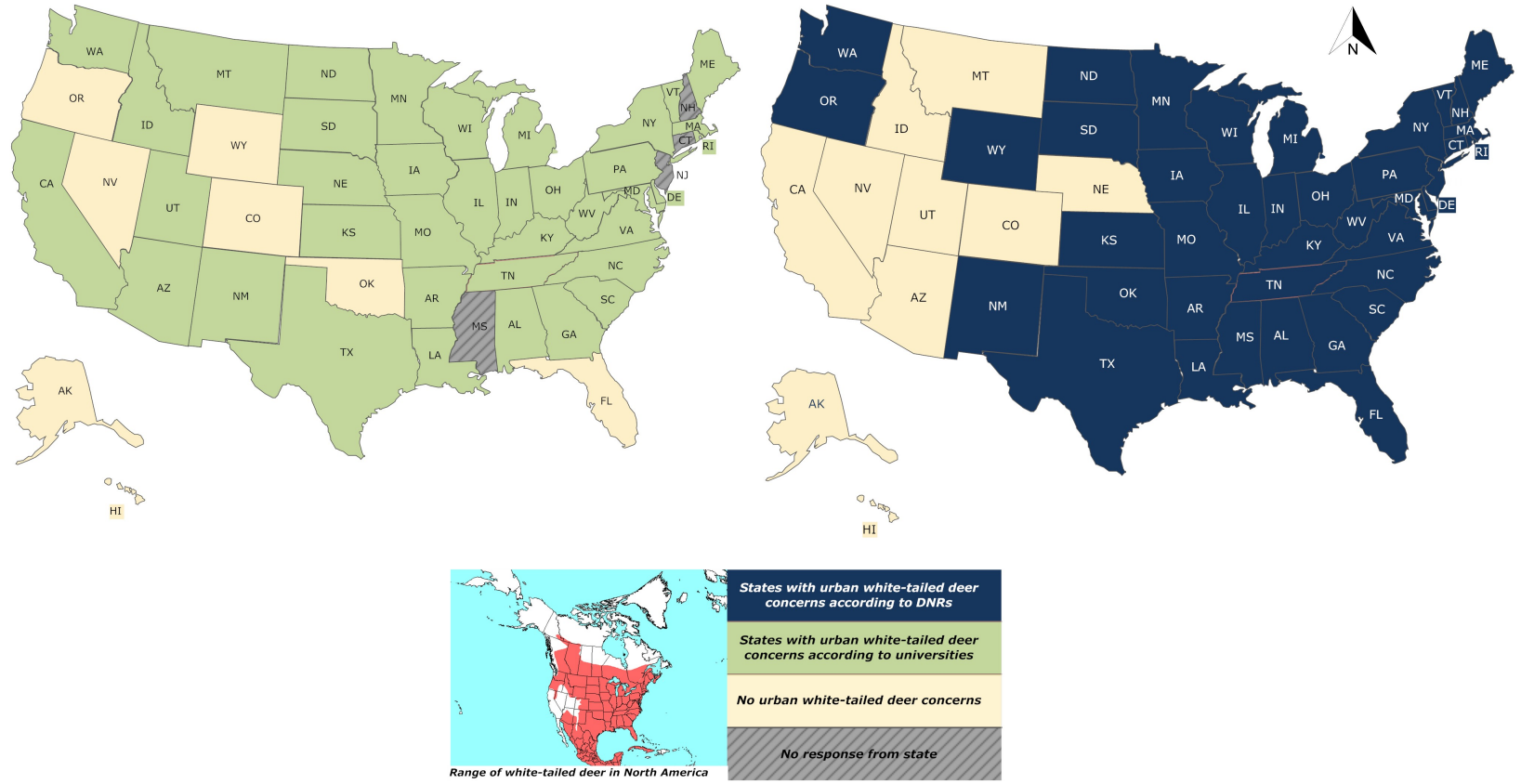

Figure 3.7. States with urban white-tailed deer concerns according to universities with wildlife programs (on the left) and state DNRs (on the right) in 2014. Seventy-four percent of university respondents and 80% percent of DNR respondents reported a problem with white-tailed deer in urban areas in their state.

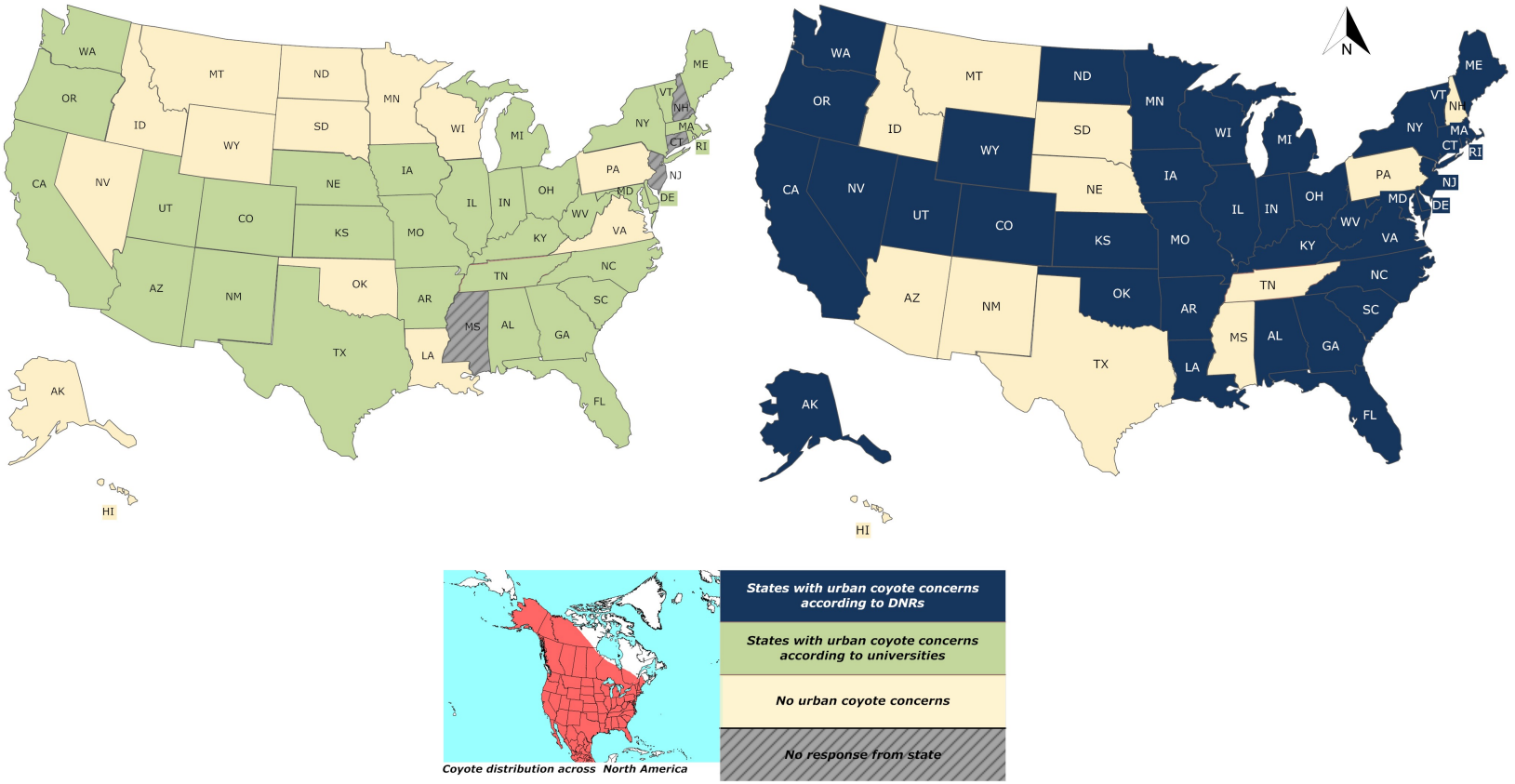

Figure 3.8. States with urban coyote concerns according to universities with wildlife programs (on the left) and state DNRs (on the right) in 2014. Sixty-six percent of university respondents and 76% percent of DNR respondents reported a problem with coyotes in urban areas in their state.

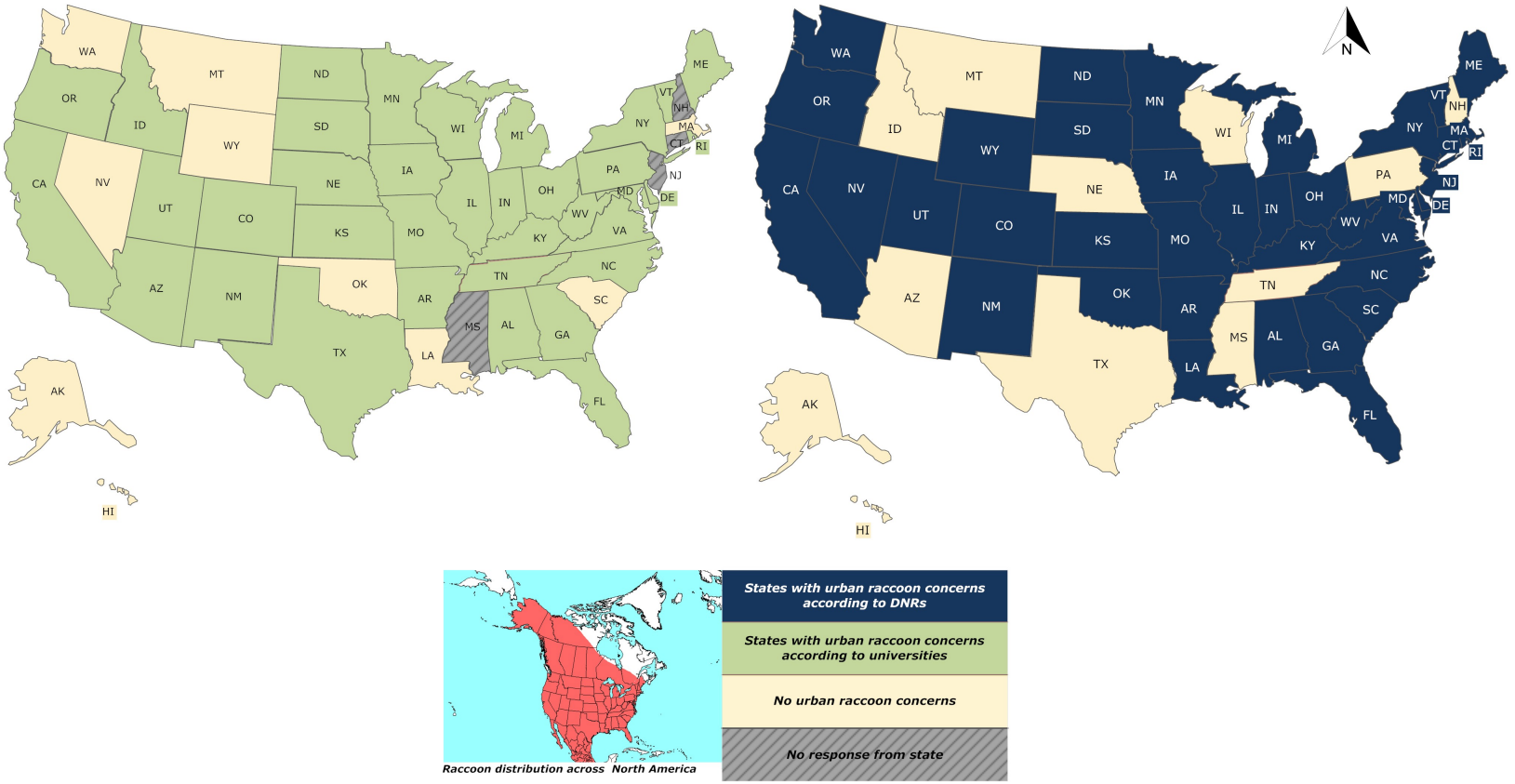

Figure 3.9. States with urban raccoon concerns according to universities with wildlife programs (on the left) and state DNRs (on the right) in 2014. Seventy-three percent of university respondents and 76% percent of DNR respondents reported a problem with raccoons in urban areas in their state.

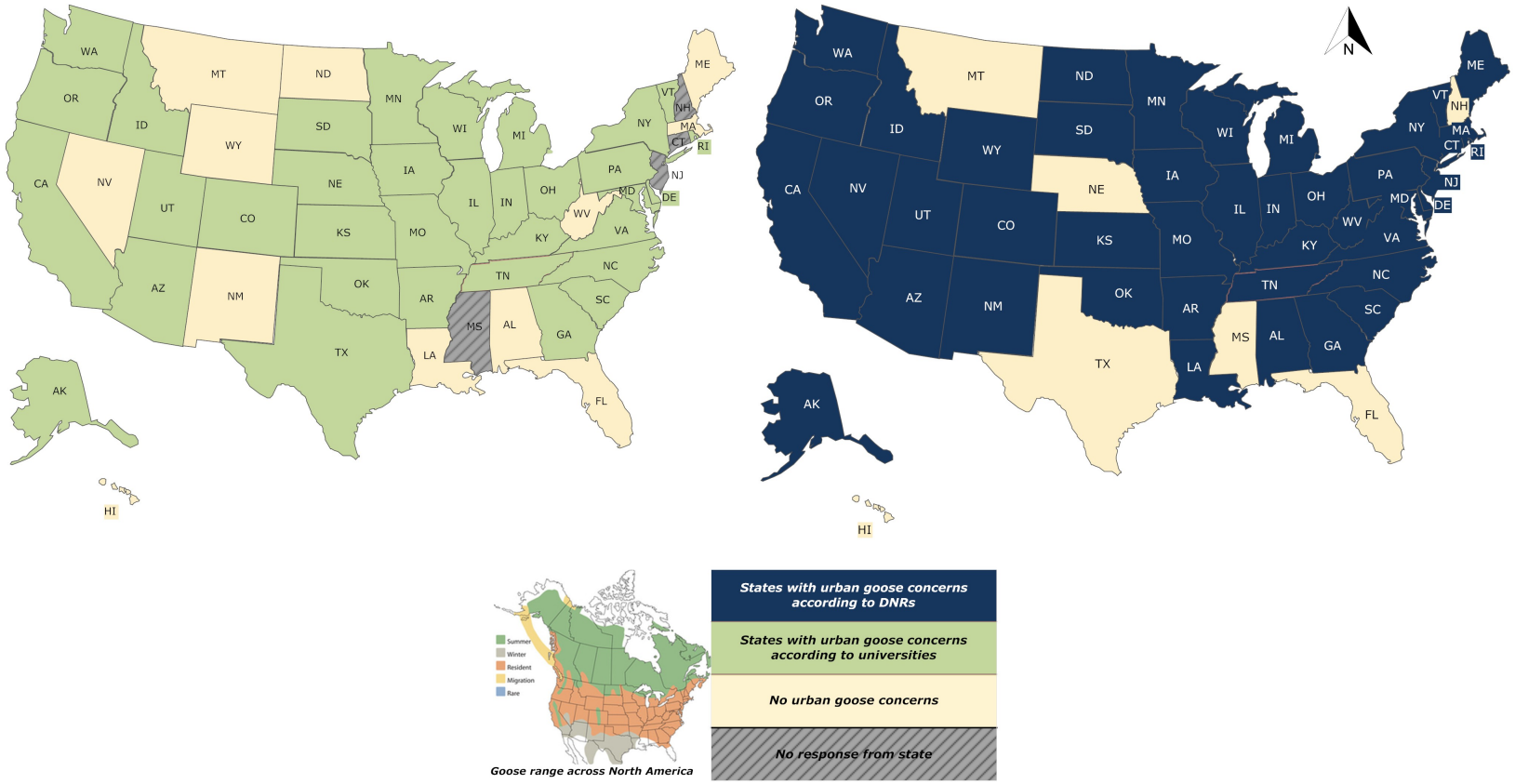

Figure 3.10. States with urban goose concerns according to universities with wildlife programs (on the left) and state DNRs (on the right) in 2014. Sixty-six percent of university respondents and 88% percent of DNR respondents reported a problem with geese in urban areas in their state.

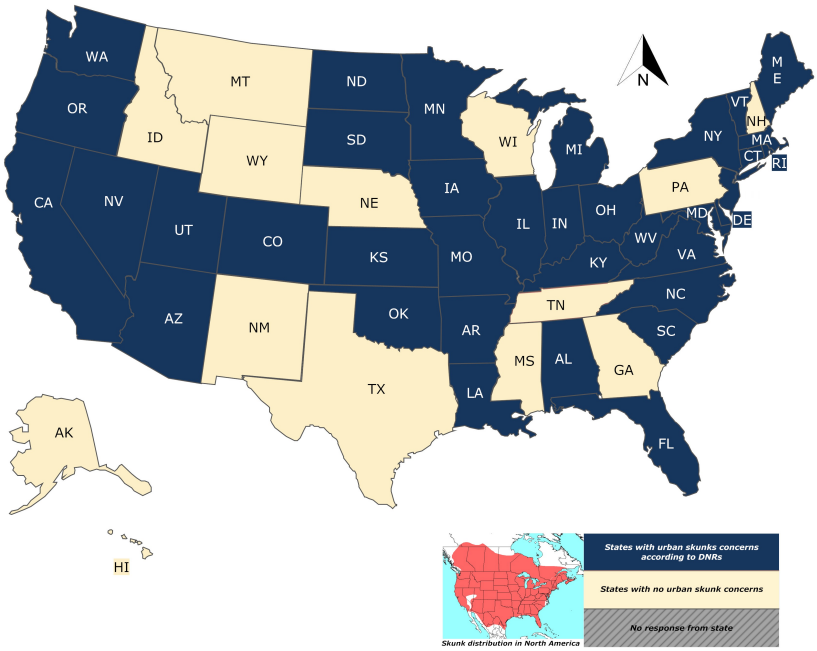

Figure 3.11. State wildlife agency respondents that reported skunks as a problematic species in urban areas in their state in 2014.

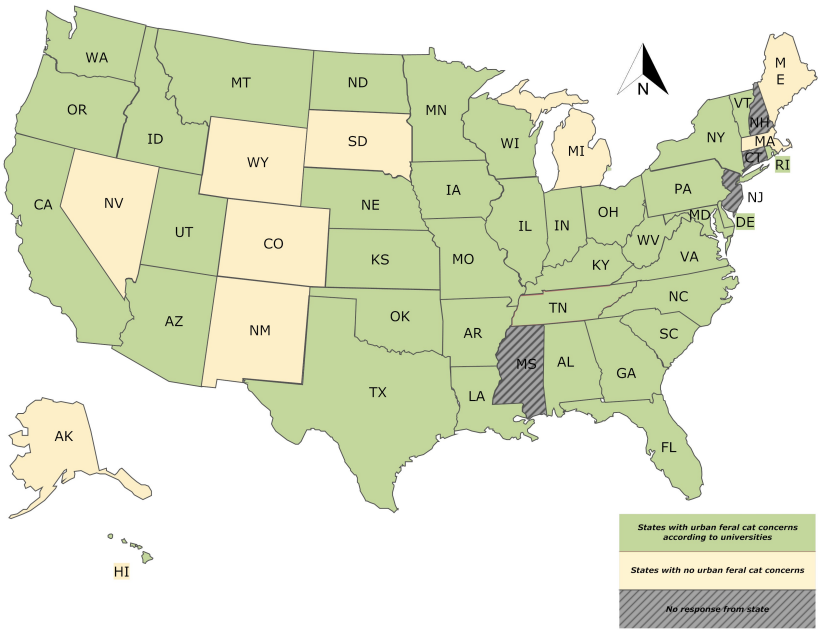

Figure 3.12. States in which at least one university reported feral cats as a problematic species in urban areas in their state in 2014.

3.5. Predicting the need for an urban wildlife management infrastructure

There were no models that best predicted DNR involvement in urban wildlife management issues (Table 3.12). Three models were competitive but this included the intercept only (null) model. No single model best predicted university involvement in urban wildlife management issues in their state as there were three models with a ΔAIC less than 2, one of which was the intercept only (null) model (Appendix A1).

No single model best predicted the proportion of urban wildlife biologists within their agency compared to other wildlife employees (Appendix A2); three models were competitive but this included the intercept only (null) model as the top model. Similarly, there were no models that predicted the proportion of urban wildlife biologists in university wildlife departments (Appendix A3).

The null model best predicted the relative number of urban wildlife biologists within each DNR (Appendix A4). Six models were competitive in predicting number of urban wildlife biologists within universities but this included the null model (Appendix A5), which indicated that none of the variables examined were influential.

The null model best predicted frequency of urban wildlife publications produced by DNRs (Appendix A6) indicating that none of the variables examined were influential. Two models were competitive in predicting frequency of urban wildlife publications produced by universities (Appendix A7), both of which included participation in wildlife activities. However, using participation in wildlife activities as a predictor variable was not significant ($p = 0.26$) and explained only a small amount of the variability associated with the data (generalized $R^2 = 0.04$).

Table 3.12. Results of logistic regression models predicting state wildlife agency involvement in urban wildlife management issues in their state.

Model	***p***	**AICc**	**ΔAIC**	***w***
Participation in wildlife activities	2	28.82	0.00	0.28
Intercept only	1	29.09	0.27	0.25
Percent population in urban areas	2	30.38	1.57	0.13
Per capita urban economic loss + Participation in wildlife activities	3	31.07	2.25	0.09
Percent population in urban areas + Participation in wildlife activities	3	31.12	2.30	0.09
Per capita urban economic loss	2	31.27	2.45	0.08
Percent population in urban areas + Per capita urban economic loss	3	32.66	3.84	0.04
Percent population in urban areas + Per capita urban economic loss + Participation in wildlife activities	4	33.48	4.66	0.03

4. DISCUSSION

4.1. Current status of urban wildlife management in DNRs and universities

This study showed that even though urban wildlife management should be a critical concern nationwide, it appeared that the structure for urban wildlife management in DNRs and universities is still lacking. There was increasing concern for and acknowledgement of urban wildlife issues across the nation, but the majority of respondents believed that there were not enough trained biologists to handle urban wildlife management issues (Section 3.1, 3.2, Figure 3.3). Even though more urban wildlife biologists were employed in the last decade, the majority of institutions still had not employed a full time urban wildlife biologist. In 1999, there were 51 urban wildlife biologists employed in both DNRs and universities across the nation, which has increased to 126 in 2014 (Figure 3.1 and Figure 3.4). There has been a steady increase in the number of DNRs addressing urban wildlife concerns from 14 agencies in 1983, 24 in 2000, and 44 in 2014 (Adams, 2005). However 67% of universities and 66% of DNRs did not have a single full time urban wildlife biologist employed by their institution in 2014.

Urban wildlife biologists are the forefront of the urban wildlife management movement. They serve not only as the public face of urban wildlife management, but contribute extensively to urban communities by providing outreach, coordinating and implementing research efforts in urban areas, providing professional planning guidance, and managing urban wildlife populations (see what services TPWD urban wildlife

biologists provide in Appendix F). Urban wildlife biologists, in addition to managing urban wildlife populations (including nuisance species), help educate and equip the environmentally illiterate with the knowledge to make environmentally sound decisions regarding the wildlife encounters that they experience in urban areas. The presence of full time urban wildlife biologists within an institution indicated that there was an infrastructure for urban wildlife management in place as well as a concern for managing urban species.

The majority (>80%) of U.S. citizens live in urban areas and likely have many of their wildlife experiences with urban wildlife (United Nations, 2011). Efforts by urban wildlife biologists can therefore facilitate positive experiences with wildlife in urban areas and prevent human/wildlife conflict. Respondents noted that the most important urban wildlife concerns in their state were a lack of education, increasing negative human-wildlife interaction, or the prevalence of nuisance species (Figure 3.1, 3.5). More attention given to urban wildlife management by increasing public awareness and education will help mitigate human/wildlife conflict, decrease environmental illiteracy, and decrease human disconnect from the environment. Additionally, a greater research focus in urban areas would provide insight into prevention of disease spread by urban species (a prominent concern mentioned by universities), overpopulation of urban areas by nuisance wildlife species, management techniques and priorities for urban species, and natural history of urban species. Urban areas have historically had both positive and negative impacts on various species, and research conducted in urban areas may help

provide further insight for the management of wildlife living in urban areas (including endangered as well as nuisance species).

Urban wildlife management is still not a priority at either state DNRs or universities. This is likely due to a lack of funding, time, and misconceptions regarding urban wildlife biologists. As one university respondent commented, "wildlife managers need to get beyond urban biologists being associated as rat catchers in order to become more involved with the opportunities for research, funding, and problem-solving that urban areas provide."

4.2. Lack of full time urban wildlife personnel

Rather than employ urban wildlife specialists, most universities and DNRs (if they addressed urban wildlife management concerns in their state) employed biologists who incorporated urban issues into their other job responsibilities. Few state DNRs employed biologists specifically for urban wildlife management. The majority of DNRs (92%) and universities (70%) used their existing wildlife biologists rather than urban wildlife biologists to address urban issues (Table 3.2, Table 3.8). University faculty may have volunteered for urban wildlife related tasks or incorporated urban issues into their classes, but few were employed for the sole purpose of urban wildlife management.

Without the personnel (a main infrastructure component) devoted to address urban wildlife management concerns, programs, research, and issues in urban areas will likely not be adequately addressed. One DNR respondent noted that because their state does not have specific urban wildlife biologists, it was difficult to stay proactive because

urban wildlife efforts were largely reactionary and driven by immediate needs or requests. At institutions that did not have an urban wildlife biologist, urban wildlife management issues were either addressed as they occurred, ignored, or handed off to another organization.

4.3. The stumbling block of limited funding

Limited funding was the primary factor that prevented further development of urban wildlife management programs and the hiring of full time personnel devoted solely to urban wildlife (Figure 3.3, 3.6). Additionally, respondents believed that other wildlife issues took precedence over urban wildlife management concerns (Figure 3.3, 3.6). Strategic plans, wildlife action plans, and other guiding documents set the direction, priorities, and focus of wildlife management at universities and DNRs, however funding is one of the main factors that determines which priorities can be addressed. Urban wildlife management was not considered to be a priority.

The 1938 Pittman-Robertson Federal Aid in Wildlife Restoration Act directed an excise tax on firearms and ammunition towards wildlife conservation, which is where state agencies have traditionally received their funding from (16 U.S.C. 669-669I). Because funding for conservation efforts comes primarily from hunters, state agencies primarily direct their time and efforts back to wildlife management for hunting. Some states, including Texas, use Pittman-Robertson (PR) funds to support their urban wildlife management needs (R. Heilbrun, personal communication, May 9, 2014). Money acquired by the Pittman-Robertson Act is required to be used on birds, mammals, and

the habitat that supports them. By managing for birds, mammals, and habitat in urban communities as well as providing technical guidance to urbanites, DNR employees can direct PR funds towards urban wildlife management while still adhering to the requirements of the Act (R. Heilbrun, personal communication, May 9, 2014).

Despite being able to use PR funds for urban wildlife management, it is not a constant source of funding, as states typically prefer to use those funds for traditional wildlife management (therefore benefitting hunters, the main contributors of the funds). There was no directed funding source at state agencies specifically for urban wildlife management. Ultimately, in order to sustain an emphasis on urban wildlife management, state agencies will need a constant, dedicated funding source that can be accounted for in long-term urban wildlife planning. These alternative funding sources should focus on reaching constituents that would benefit from wildlife management in urban areas, but are not currently paying for the benefits of conservation through the PR Act.

There have been some efforts and methods to garner funding for urban wildlife efforts. The Teaming With Wildlife funding initiative (a national endeavor) was designed to provide an excise tax to include on other outdoor recreational products, in order to finance efforts for non-game species (including urban) management at state agencies, though no significant progress was made (Franklin & Reis, 1996). Some states have used a variety of methods to raise funds for non-game management, including sales taxes, fees for land sales, license plate programs, lottery sales, and additional fees on water bills. States may also consider working with municipalities and other agencies to

add a tax on electric bills, garbage collection fees, or driver's licenses. Using volunteers (including Master Naturalists) may also increase efforts for wildlife management in urban areas without requiring additional funds.

Limited funding at universities is likely due to a lack of available contracts and grants for research in urban environments. Additionally, a large proportion (37%) of universities believed there were not enough interested researchers to focus on urban wildlife (Figure 3.6). This would probably not be the case if grants and contracts for urban wildlife research were available.

Despite the lack of funding and small number of urban wildlife biologists, the majority of respondents reported that there was a strong public demand for urban wildlife management in their state, and that their institution was involved in addressing urban wildlife management issues (Section 3.1, 3.2). However, the lack of employees devoted solely to urban wildlife management, lack of urban wildlife research, and the small number of urban wildlife biologists believed to be needed to adequately address issues suggested that the infrastructure for urban wildlife management is still lacking. Without proper funding, urban wildlife management will continue to be underemphasized in both DNRs and universities.

4.4. Structure in urban wildlife programs at universities

Universities play a crucial role in providing the academic environment to train undergraduate and graduate students in wildlife science and management. Curricula and research geared towards urban wildlife research was lacking prior to the 21st century

(Adams, 2003; Adams et al., 1987). The average number of universities per state that offered wildlife programs with a B.S. degree has nearly doubled since 1999 (Table 3.11). The number of universities teaching urban wildlife management courses has also doubled since 1999 (Table 3.11). However universities teach an average of 0.57 urban wildlife courses (Table 3.11), which will not support an increased future emphasis on urban wildlife. If students cannot receive training for urban wildlife management at universities, they will be underprepared to address urban wildlife management issues in the professional world. Because of the important role university programs play in training and equipping wildlife students to accomplish their job duties, it is essential that universities emphasize and promote urban wildlife management within their program (Adelman et al., 1994).

Though universities are often limited in changing or altering their academic programs, if given the opportunity there are several changes that would help set up a stronger infrastructure within universities to address urban wildlife management. An increased number of courses and training (including hands on lab opportunities) for students will better prepare them to address urban wildlife concerns in their profession. Training in conflict management and human dimensions of wildlife management would help students respond appropriately to the public, not only in urban settings, but in other job positions as well. Maintaining ties with municipal governments and animal damage control groups can facilitate internship opportunities for students that can help them gain hands on experience addressing urban wildlife concerns. Lastly, universities could

develop a curriculum for an urban wildlife professional based on the qualifications and tasks that DNRs listed as being important (Section 3.1, Table 3.3, 3.4).

4.5. Predicting urban wildlife infrastructure

None of the models or variables tested were relevant predictors of various aspects of urban wildlife infrastructure at DNRs or universities (Appendix A). It is likely that there were other factors that influenced the proportion of employees that were devoted solely to urban wildlife management, frequency of urban wildlife publications, and institutional involvement in addressing urban wildlife management concerns. Considering the main limitation preventing greater DNR and university involvement in urban wildlife management was funding (Figure 3.1, 3.3), it is likely that funding sources and amount may well dictate the presence or absence of an urban wildlife program within institutions. Future research should take a closer look at what might be the primary drivers of urban wildlife management, especially taking into consideration funding sources.

4.6. Communication between wildlife institutions

A functional infrastructure is based on a clear line of communication and established priorities within and between institutions. A closer look at some of the questions in this study revealed the need for clearer communication between organizations responsible for wildlife management across the nation. There were some states during the course of this study in which DNRs and universities differed in their

responses to questions, primarily regarding what urban wildlife management issues were relevant in their state as well as what urban species were considered to be of special concern. For states with multiple universities responses, there were occasions when responses differed between universities. It was difficult to interpret why respondents from the same state did not respond similarly when selecting some of their most pressing wildlife concerns. Some of the response variation may be due to a different question interpretation, however it is possible that the lack of consistency was due to poor communication and differing management priorities between institutions.

Research interests and frequency of types of publications varied between DNRs and universities (Figures 3.2 and 3.5, respectively). DNRs produced publications on game species more frequently than universities, and universities produced publications on non-game species more frequently than DNRs. It is likely that in addition to different research interests, DNRs and universities also have different management interests when compared to each other and other wildlife management agencies (e.g., USFWS, USDA, and the National Park Service). Different wildlife management agendas broaden the scope of management if these differences are communicated clearly between agencies and academic institutions. In order to maximize productivity and prevent redundancy when addressing urban wildlife management, universities and DNRs should coordinate and communicate about current urban wildlife concerns, management recommendations, and research interests. In addition, communication with other stakeholders including municipal governments, urban planners, homeowner associations, and federal organizations (among others) to prioritize and address urban wildlife concerns would

allow for a more efficient use of limited funding, reduce interagency conflict, and facilitate cooperation between stakeholders.

The Wildlife Society (TWS) Urban Wildlife Working group is one of the main organizations in the nation that facilitates urban wildlife management discussion between universities and other interested organizations. They hold workshops and sessions at most TWS annual meetings which are usually focused on various topics related to urban wildlife management including evolution in urban landscapes, translocation with wildlife animal damage control, and urban and environmental justice. Their annual planning meetings generally consisted of approximately 30 individuals, the majority of which were from universities (The Urban Wildlife Working Group, 2012). They shared pertinent information through their web page, new forms of media including Facebook, and email updates. Prior to 2012, they produced a biannual newsletter that was distributed to interested participants. Approximately every two years, they organize and help host the International Urban Wildlife Symposia. The meetings, workshops, and newsletters have helped to facilitate communication about urban wildlife efforts across the nation as well as abroad.

However, the working group is voluntary and is not funded, and as a result it is difficult to sustain interest and participation (R. McCleery, personal communication, May 12, 2014). A greater percentage of DNRs and universities should voluntarily participate and coordinate with the Urban Wildlife Working Group (or another overarching group) in order to make a more unified effort to develop the structure and agenda for urban wildlife management. Other organizations involved with urban wildlife

should also participate in the collaborative effort, either through the Urban Wildlife Working group or by making a conscious effort to communicate with other urban wildlife management agencies. DNRs need to make a conscious effort to attend academic meetings and communicate with university researchers. Increased coordination and communication between various organizations involved in urban wildlife management would maximize productivity and strengthen support for urban wildlife management across the nation.

4.7. Other wildlife agencies involved with urban wildlife management

As demonstrated by Figure 1.1, there are other agencies and institutions involved in urban wildlife management. A percentage of DNR (6%) and university (41%) respondents reported that urban wildlife management concerns in their state are the responsibility of another state agency (Tables 3.2 and 3.8, respectively). DNR respondents commented that urban wildlife management issues in their state are often referred to USDA Wildlife Services. Similarly, university respondents reported that if they did not handle wildlife issues themselves, they were typically handled by state DNRs or USDA Wildlife Services. USFWS has established the Urban Wildlife Refuge Initiative, which was designed to provide a refuge presence and raise awareness of conservation in urban areas (USFWS, 2014). The National Wildlife Federation established the Backyard Wildlife Habitat Program early in the urban wildlife movement in 1973, which was designed to educate citizens and motivate them to enhance urban wildlife habitat in their yards (National Wildlife Federation, 1974). In addition, the Trust

for Public Land shifted part of their focus to urban areas with the Green Cities Initiative, which was developed in order to meet open space needs of urbanites (Adams, 2005).

Additionally, 32% and 37% of DNR and university respondents, respectively, agreed that urban wildlife management issues within their state were also the responsibility of private organizations (Tables 3.2 and 3.8, respectively). These organizations included municipal governments, animal control operators, e.g., Critter Control, humane societies, and Master Naturalist Programs. Because these organizations play a significant role in addressing urban wildlife issues in states, they needed to be included in further research and urban wildlife program development. Clear communication regarding urban wildlife needs and interests must be established between not only DNRs and universities but also other organizations that are involved in addressing urban wildlife needs (Figure 1.1).

Several universities (including Cornell and Rutgers, two leading Land Grant Institutions) with staff or faculty involved with urban research interests were excluded from this study because their department did not fit our survey criteria of having a wildlife degree or $\geq$10 wildlife courses. These universities had a biology related degree program with a few wildlife courses or a minor in wildlife-related sciences. It is unfortunate that these universities were excluded from this study. However these omissions emphasized the need for clear guidelines and communication for establishing and naming wildlife degree programs. If there were national standards for developing and naming university wildlife programs, the decision to include or exclude universities from this study would have been clearer.

4.8. Involving the public

The primary concern of respondents was a perceived lack of public awareness and public education regarding urban wildlife. Despite the controversy surrounding wildlife in urban areas, the best way to preserve urban biodiversity is to instill an interest and passion for wildlife in people. Conserving urban biodiversity has multiple benefits including: preserving local biodiversity, improving human well-being, facilitating understanding of environmental change, and creating stepping stones to nonurban habitat (Dearborn & Kark, 2010).

Urban wildlife programs need to put forth a conscious effort to involve and educate the public in how to address urban wildlife concerns. Urban wildlife biologists should coordinate with nature centers, municipal governments, schools, and other public venues in order to share vital information and stimulate public involvement. Wildlife in urban areas will inevitably involve both willing and unwilling urbanites by moving into their homes (i.e. attics) and causing property damage.

Conover (1997) estimated that households across the nation lost approximately $3.8 billion from wildlife damage and spent an additional $1.9 billion and 268 million hours trying to prevent or solve household wildlife problems. Educating citizens about wildlife encounters and how to respond appropriately to wildlife issues helps individuals have more positive interactions with wildlife and may prevent further conflict. On the other hand, urban households were estimated to have spent $3.6 billion and 1.3 billion hours annually encouraging wildlife visitation near their homes (Conover, 1997). Many programs, including the Backyard Wildlife Habitat Program responds to this citizen

desire and educates homeowners across the nation about the benefits of enhancing wildlife habitat in their yards (National Wildlife Federation, 1974).

Master Naturalist Programs have provided a way for citizens to become involved in traditional management and conservation goals by including training and education for urban residents in their programs (Arkansas Master Naturalists, 2014; Texas Parks and Wildlife, 2014; University of Illinois Board of Trustees, 2014). Multiple DNRs and agencies have offered urban-related workshops and conferences that are open to the public. Wildlife institutions need to continue and improve how they reach out to citizens in urban areas through urban wildlife biologists, urban wildlife programs, social media, and other unique means in order to increase public awareness of, interest in, and responsibility toward the wildlife that is in their backyards.

4.9. Future research

This study revealed an increased focus on urban wildlife management in the last decade in state DNRs and universities. Because this study focused on only two of the main stakeholders of urban wildlife management, future research should examine the involvement of USDA Wildlife Services, USFWS, municipal governments, and animal damage control services (other stakeholders are shown in Figure 1.1). This would be useful in providing a more holistic examination of the infrastructure for urban wildlife management. Additionally, urbanites should be surveyed to determine who they perceive to be in control of urban wildlife management. This study would help wildlife managers realize what agencies or organizations the public recognizes as sources of assistance

with their urban wildlife management problems, what type of problems are most common in urban areas, and provide recommendations for the most effective urban wildlife management efforts that help and engage the public. Measuring the effectiveness of the infrastructure for urban wildlife should also be considered when planning future research endeavors. On a localized scale, surveying the public, monitoring number of calls to wildlife hotlines, measuring participation in wildlife activities (particularly those in urban environments), and assessing size and engagement on urban wildlife webpages can all be used to assess the effectiveness of addressing urban wildlife concerns in focal areas.

Adams et al. (1987) conducted a national study of colleges and universities to determine the extent of research, teaching and extension activities focused on urban wildlife management. The study determined that less than 10% of universities have staff, research projects, funding, or classes that were devoted to urban wildlife management. However, there may have been changes in university wildlife programs since then, and it would be helpful to conduct a replication of that study in order to assess what changes have transpired in the last 25 years. For example, this study has shown some progress in the last decade. Funding is still a major limitation for university emphasis on urban wildlife management, but in 33% of university respondents had urban wildlife faculty in 2014 (Section 3.2). Another study might include a more extensive examination of how urban wildlife research is funded, funding levels, and how academic programs have progressed. A study in this area would offer recommendations for how to improve a

university emphasis on urban wildlife management and would suggest where future effort in universities would be best directed.

5. CONCLUSIONS

Wildlife management in the U. S. was originally designed to address the needs of what was mostly a rural agrarian society. Urbanization has increased to the point where the majority of U.S. citizens now live in urban areas, and wildlife management has shifted away from the historical focus on game management for hunting and predator control (Patterson, Montag, & Williams, 2003). Increased environmental illiteracy, changing wildlife values, the prevalence of nuisance and invasive species, and an increased concern over negative human-wildlife encounters requires a new focus on wildlife management. As exhibited by the model (Figure 1.1), urban wildlife management is distinguished from traditional rural management by its association with anthropogenic environments and interactions between selected wildlife species and humans.

Across the nation, universities and DNRs have provided support for managing wildlife in urban environments. Without an infrastructure for urban wildlife management provided by universities and state DNRs, the nation will continue to experience increasing human-wildlife conflict, environmental illiteracy, overpopulation of urban areas by nuisance wildlife species, and human disconnect from the environment. Infrastructure is necessary in order to establish priorities for a more smoothly functioning organization, and provide a more reliable production of services and products to meet public needs. The existence of an infrastructure for urban wildlife management can be measured by the level of communication between involved

organizations, funding and personnel devoted solely to urban wildlife management, and the successful generation of products (including research publications and educational programs) related to urban wildlife management.

Urban wildlife management is a growing concern for universities and DNRs, considering the lack of educational programs about urban wildlife, growing public concern about human-wildlife encounters, and increasing levels of nuisance species in urban environments. The majority of university and DNR respondents agreed that there was a public demand for urban wildlife management in their state and also agreed that their institution was involved in urban wildlife management concerns. However, respondents reported a total of only 126 full time urban wildlife biologists in DNRs and universities across the nation. This was more than twice the number of urban wildlife biologists reported by Adams (2003), but the majority of DNRs and universities do not have an urban wildlife biologist within their institution. Urban wildlife biologists provide urban communities with professional planning guidance, wildlife management, and outreach; as such, they are a crucial part of the infrastructure for urban wildlife management. Just as "urbanites need to get out of the cities and into the woods", wildlife biologists need to get out of the woods and into the cities (Dasmann, 1966).

This study showed that funding was the primary limitation preventing a greater emphasis on urban wildlife management in state DNRs and universities. Additionally, many respondents believed there were more important wildlife management issues to be addressed. Despite these limitations, urban wildlife management concerns should be addressed using clear support and communication strategies. Though there has been

progress in the last two decades in establishing an infrastructure for urban wildlife management, there are still urban wildlife concerns across the nation that are not being addressed. It is up to federal and state agencies, universities, private organizations, and municipal governments to make the changes within their organizations to help improve the efficiency of an infrastructure designed to address urban wildlife management across the nation.

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APPENDIX A

Table A1. Results of logistic regression models predicting university involvement in urban wildlife management issues in their state.

Model	*K*	AICc	ΔAIC	*w*
Participation in wildlife activities	2	81.58	0.00	0.30
Intercept only	1	82.30	0.73	0.21
Percent population in urban areas + Participation in wildlife activities	3	82.88	1.31	0.16
Per capita urban economic loss + Participation in wildlife activities	3	83.76	2.19	0.10
Percent population in urban areas	2	84.27	2.70	0.08
Per capita urban economic loss	2	84.43	2.85	0.07
Percent population in urban areas + Per capita urban economic loss + Participation in wildlife activities	4	85.12	3.54	0.05
Percent population in urban areas + Per capita urban economic loss	3	86.47	4.89	0.03

Table A2. Results of logistic regression models predicting the proportion of wildlife employees at DNRs that are full-time urban wildlife biologists.

Model	*K*	AICc	ΔAIC	*w*
Intercept only	1	-164.98	0.00	0.36
Participation in wildlife activities	2	-163.29	1.69	0.15
Per capita urban economic loss	2	-163.28	1.70	0.15
Percent population in urban areas	2	-162.68	2.30	0.11
Percent population in urban areas + Participation in wildlife activities	3	-161.76	3.22	0.07
Per capita urban economic loss + Participation in wildlife activities	3	-161.74	3.24	0.07
Percent population in urban areas + Per capita urban economic loss	3	-160.83	4.15	0.04
Percent population in urban areas + Per capita urban economic loss + Participation in wildlife activities	4	-160.43	4.55	0.04

Table A3. Results of linear regression models predicting the proportion of wildlife employees at universities that are full-time urban wildlife biologists.

Model	*K*	AICc	ΔAIC	*w*
Intercept only	1	-49.80	0.00	0.33
Per capita urban economic loss	2	-48.94	0.86	0.22
Percent population in urban areas	2	-47.82	1.98	0.12
Participation in wildlife activities	2	-47.61	2.19	0.11
Percent population in urban areas + Per capita urban economic loss	3	-46.89	2.91	0.08
Per capita urban economic loss + Participation in wildlife activities	3	-46.69	3.11	0.07
Percent population in urban areas + Participation in wildlife activities	3	-45.68	4.12	0.04
Percent population in urban areas + Per capita urban economic loss + Participation in wildlife activities	4	-44.60	5.20	0.02

Table A4. Results of linear regression models predicting the relative number (none, one, or more than one) of urban wildlife biologists at DNRs.

Model	*p*	AICc	ΔAIC	*w*
Intercept only	1	80.00	0.00	0.24
Per capita urban economic loss	2	80.47	0.47	0.19
Percent population in urban areas	2	80.94	0.94	0.15
Percent population in urban areas + Per capita urban economic loss	3	81.25	1.25	0.13
Percent population in urban areas + Participation in wildlife activities	3	82.13	2.13	0.08
Participation in wildlife activities	2	82.21	2.21	0.08
Percent population in urban areas + Per capita urban economic loss + Participation in wildlife activities	4	82.82	2.82	0.06
Per capita urban economic loss + Participation in wildlife activities	3	82.84	2.85	0.06

Table A5. Results of logistic regression models predicting the relative number (none, one, or more than one) of urban wildlife biologists at universities.

Model	*K*	AICc	ΔAIC	*w*
Percent population in urban areas + Per capita urban economic loss	3	146.22	0.00	0.22
Percent population in urban areas	2	146.58	0.37	0.18
Participation in wildlife activities	2	147.27	1.05	0.13
Per capita urban economic loss + Participation in wildlife activities	3	147.46	1.24	0.12
Intercept only	1	147.68	1.46	0.10
Per capita urban economic loss	2	147.81	1.59	0.10
Percent population in urban areas + Per capita urban economic loss + Participation in wildlife activities	4	148.25	2.03	0.08
Percent population in urban areas + Participation in wildlife activities	3	148.41	2.20	0.07

Table A6. Results of logistic regression models predicting relative frequency (never, occasionally, or frequently) of publishing urban wildlife literature by DNRs.

Model	*p*	AICc	ΔAIC	*w*
Intercept only	1	79.77	0.00	0.39
Percent population in urban areas	2	81.08	1.31	0.20
Per capita urban economic loss	2	82.00	2.23	0.13
Participation in wildlife activities	2	82.96	3.18	0.08
Percent population in urban areas + Participation in wildlife activities	3	83.16	3.39	0.07
Percent population in urban areas + Per capita urban economic loss	3	83.44	3.67	0.06
Per capita urban economic loss + Participation in wildlife activities	3	84.39	4.62	0.04
Percent population in urban areas + Per capita urban economic loss + Participation in wildlife activities	4	85.62	5.85	0.02

Table A7. Results of logistic regression models predicting relative frequency (never, occasionally, or frequently) of publishing urban wildlife literature by universities.

Model	*K*	AICc	ΔAIC	*w*
Participation in wildlife activities	2	101.27	0.00	0.34
Per capita urban economic loss + Participation in wildlife activities	3	102.02	0.75	0.24
Percent population in urban areas + Participation in wildlife activities	3	103.48	2.21	0.11
Percent population in urban areas + Per capita urban economic loss + Participation in wildlife activities	4	104.35	3.08	0.07
Intercept only	1	104.45	3.18	0.07
Per capita urban economic loss	2	104.56	3.29	0.07
Percent population in urban areas	2	105.07	3.79	0.05
Percent population in urban areas + Per capita urban economic loss	3	105.22	3.95	0.05

APPENDIX B

UNIVERSITY QUESTIONNAIRE

Welcome

Please respond to each question to the best of your ability. The survey should take approximately 20 minutes to complete, and all responses are confidential. If you have any questions or concerns about this research, please contact the Principal Investigators listed below, or you may contact Texas A&M IRB (proposal number is IRB2013-0813) at irb@tamu.edu. Your participation is this study is voluntary, and there will be no loss of benefits to which you are otherwise entitled if you do not participate or discontinue participation at any time during the survey. Thank you for your participation!

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***1. Please enter the four digit access code provided in your invitation email:**

2. What state do you represent?

State:

3. How many faculty within your department have a PhD in wildlife or biological sciences (including Extension Services)?

Faculty

4. Which of the following statements about urban wildlife management are relevant in your state? (Mark all that apply.)

- ☐ Urban wildlife management is a growing concern in natural resource management.
- ☐ Urban wildlife management will probably become the dominant future focus in this state.
- ☐ Several species of wildlife are increasing to nuisance levels in urban communities.
- ☐ There is a growing human curiosity about wildlife in urban communities.
- ☐ There is a growing concern about human/wildlife encounters in urban communities.
- ☐ People living in urban communities need educational programs about the wildlife around them.
- ☐ There are not enough trained and equipped biologists to handle urban wildlife management issues.
- ☐ There are NO urban wildlife management issues relevant to this state.

Other issues (please specify)

5. Your department is involved in urban wildlife management concerns in your state.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
○	○	○	○	○

6. How are urban wildlife management issues addressed in your state? (Mark all that apply.)

- ☐ Handled by our urban wildlife biologist(s).
- ☐ Responsibility of another state agency.
- ☐ Use existing wildlife (field) biologists.
- ☐ Responsibility of private organizations
- ☐ There are NO urban wildlife management issues to address in this state.

Other (please specify)

7. There is a public demand for urban wildlife management in your state.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	N/A
◯	◯	◯	◯	◯	◯

Comments:

Urban Wildlife Biologist

An urban wildlife biologist is an individual who works or conducts research PRIMARILY in urbanized environments with a focus on non-domestic vertebrate and invertebrate species and human associations with wildlife (including education and conflict resolution).

8. Based on the above definition of an urban wildlife biologist, how many faculty within your department fit this definition (enter 0 if none)?

Total positions: ____

9. How many urban wildlife biologist positions are needed within your department to address the urban wildlife management issues you identified in question #4 (enter 0 if none)?

Additional positions ____

10. Which of the following QUALIFICATIONS would be or are required of an urban wildlife biologist employed by your department? (Mark all that apply.)

- ☐ Be able to integrate wildlife management concerns into urban development and landscape design.
- ☐ Be able to recognize and evaluate the effects of urbanization on habitat.
- ☐ Know identifying characteristics, life histories, and habitat requirements of highly visible urban wildlife species.
- ☐ Be able to identify and explain wildlife utilization of local native flora and cultivated plant species.
- ☐ Have a working knowledge of nature interpretation.
- ☐ Be willing and able to be interviewed by mass media.
- ☐ Understand how municipal, county, state, and Federal governments work.
- ☐ Have a basic understanding of environmental laws and regulations.
- ☐ Be willing and able to handle and solve urban wildlife damage and nuisance complaints.
- ☐ Be able to evaluate public attitudes, activities, and expectations concerning urban wildlife.
- ☐ Does not need a PhD in wildlife or biological sciences to be employed.
- ☐ None of the above

Other (please specify)

____

11. Which of the following TASKS would be or are required of urban wildlife biologists employed by your department? If you answered "0" to the number of urban wildlife biologists within the department in Question 8, please check the tasks that are required of other faculty within your department. (Mark all that apply.)

- ☐ Animal damage control.
- ☐ Conduct community educational programs about urban wildlife.
- ☐ Organize urban youth hunts.
- ☐ Establish urban wildlife habitats (e.g., backyard wildlife).
- ☐ Produce publications about urban wildlife.
- ☐ Offer school programs on urban wildlife.
- ☐ Conduct research focused on urban wildlife management.
- ☐ Operate urban nature centers.
- ☐ Furnish urban ecosystem management information to the public.
- ☐ Work with local government in urban planning.
- ☐ Work with urban community (neighborhood) groups.
- ☐ Work with developers.
- ☐ None of the above

Other (please specify)

12. How many universities or colleges in your state (enter 0 if none):

offer a B.S. degree that includes wildlife sciences? ☐

offer courses in wildlife sciences? ☐

offer a course in urban wildlife management? ☐

Urban Wildlife Research

Urban wildlife research investigates animal behavior, population and community ecology, landscape ecology, conservation and wildlife restoration, wildlife management, wildlife diseases, human-wildlife conflicts, and human perceptions of wildlife specifically in urban communities.

13. Your department faculty and students produce publications on:

	Not at all	Occasionally	Frequently
game species (not urban)	◯	◯	◯
non-game species (not urban)	◯	◯	◯
urban wildlife	◯	◯	◯

14. How many of your graduate students are focused on URBAN wildlife for their thesis or dissertation research? (Enter 0 if none and exclude non-thesis graduate students.)

Total number of undergraduate students: ☐

Total number of graduate students: ☐

Students conducting urban wildlife research: ☐

15. The animals listed below are known to cause measurable detrimental economic, human health, or habitat effects in urban communities in some states. Please check those that are of special concern in your state. (Check all that apply.)

☐ Elk	☐ Bats	☐ Gulls
☐ Moose	☐ Beavers	☐ Hawks/Owls
☐ Key deer	☐ Woodchucks	☐ Pigeons
☐ Mule deer	☐ Squirrels	☐ Sparrows
☐ White-tailed deer	☐ Feral cats	☐ Starlings
☐ Black/brown bears	☐ Feral dogs	☐ Vultures
☐ Polar bears	☐ Feral hogs	☐ Woodpeckers
☐ Foxes	☐ Blackbirds	☐ Alligators
☐ Coyotes	☐ Cattle egrets	☐ Burmese pythons
☐ Bobcats	☐ Cow birds	☐ Lizards
☐ Mountain Lions	☐ Crows	☐ Rattlesnakes
☐ Raccoons	☐ Ducks	☐ Bull frogs
☐ Skunks	☐ Geese	☐ Coqui frogs
☐ Opossums	☐ Grackles	

Other species or genera not listed above:

16. What limitations prevent greater emphasis on urban wildlife management in your department? (Check all that apply.)

- ☐ limited funding
- ☐ public opposition
- ☐ lack of interest within the department
- ☐ opposition from the university
- ☐ not viewed as scientific
- ☐ not enough researchers (including graduate students) interested in urban wildlife
- ☐ there are other more important wildlife management issues to focus on
- ☐ nothing limits our departmental teaching and research programs on urban wildlife

Other (please specify)

17. In your opinion, what is (are) the most important urban wildlife issue(s) in your state?

18. Additional Comments:

APPENDIX C

DNR QUESTIONNAIRE

Welcome

Please respond to each question to the best of your ability. The survey should take approximately 20 minutes to complete, and all responses are confidential. If you have any questions or concerns about this research, please contact the Principal Investigators listed below, or you may contact Texas A&M IRB (proposal number is IRB2013-0813) at irb@tamu.edu. Your participation is this study is voluntary, and there will be no loss of benefits to which you are otherwise entitled if you do not participate or discontinue participation at any time during the survey.

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***1. Please enter the four digit access code provided in your invitation email:**

2. Which state do you represent?

State:

3. How many employees within your agency needed at least a B.S. degree in wildlife or biological sciences or its equivalent to be hired?

Employees

4. Which of the following statements about urban wildlife management are relevant in your state? (Mark all that apply.)

- ☐ Urban wildlife management is a growing concern in natural resource management.
- ☐ Urban wildlife management will probably become the dominant future focus in this state.
- ☐ Several species of wildlife are increasing to nuisance levels in urban communities.
- ☐ There is a growing human curiosity about wildlife in urban communities.
- ☐ There is a growing concern about human/wildlife encounters in urban communities.
- ☐ People living in urban communities need educational programs about the wildlife around them.
- ☐ There are not enough trained and equipped biologists to handle urban wildlife management issues.
- ☐ There are NO urban wildlife management issues relevant to this state.

Other issues (please specify)

5. Your agency is involved in urban wildlife management concerns in your state.

Strongly disagree	Disagree	Undecided	Agree	Strongly Agree
○	○	○	○	○

6. How are urban wildlife management issues addressed in your state? (Mark all that apply.)

- ☐ Handled by our urban wildlife biologist(s).
- ☐ Responsibility of another state agency.
- ☐ Use existing wildlife (field) biologists.
- ☐ Responsibility of private organizations
- ☐ There are NO urban wildlife management issues to address in this state.

Other (please specify)

7. There is a public demand for urban wildlife management in your state.

Strongly disagree	Disagree	Undecided	Agree	Strongly Agree
◯	◯	◯	◯	◯

Comments:

Urban Wildlife Biologist

An urban wildlife biologist is an individual who works or conducts research PRIMARILY in urban, suburban, or metropolitan environments with a focus on non-domestic vertebrate and invertebrate species and human associations with wildlife.

8. Based on the above definition of an urban wildlife biologist, how many full time positions within your agency fit this definition (enter 0 if none)?

Total positions

9. How many urban wildlife biologist positions are needed within your agency to address the urban wildlife management issues you identified in question #4 (enter 0 if none)?

Additional positions:

10. Which of the following QUALIFICATIONS differentiate an urban wildlife biologist from other wildlife biologists employed by your agency? (Mark all that apply.)

- [ ] Be able to integrate wildlife management concerns into urban development and landscape design.
- [ ] Be able to recognize and evaluate the effects of urbanization on habitat.
- [ ] Know identifying characteristics, life histories, and habitat requirements of highly visible urban wildlife species.
- [ ] Be able to identify and explain wildlife utilization of local native flora and cultivated plant species.
- [ ] Have a working knowledge of nature interpretation.
- [ ] Be willing and able to be interviewed by mass media.
- [ ] Understand how municipal, county, state, and Federal governments work.
- [ ] Have a basic understanding of environmental laws and regulations.
- [ ] Be willing and able to handle and solve urban wildlife damage and nuisance complaints.
- [ ] Be able to evaluate public attitudes, activities, and expectations concerning urban wildlife.
- [ ] Does not need a B.S. degree in wildlife or biological sciences to be employed.
- [ ] There are NO qualifications that differentiate urban wildlife biologists from other wildlife biologists in our agency.

Other (please specify)

11. Which of the following TASKS differentiate urban wildlife biologists from other wildlife biologists in your state? (Mark all that apply.)

- [ ] Animal damage control.
- [ ] Conduct community educational programs about urban wildlife.
- [ ] Organize urban youth hunts.
- [ ] Establish urban wildlife habitats (e.g., backyard wildlife).
- [ ] Produce publications about urban wildlife.
- [ ] Offer school programs on urban wildlife.
- [ ] Conduct research focused on urban wildlife management.
- [ ] Operate urban nature centers.
- [ ] Furnish urban ecosystem management information to the public.
- [ ] Work with local government in urban planning.
- [ ] Work with urban community (neighborhood) groups.
- [ ] Work with developers.
- [ ] There are NO tasks or duties that differentiate urban wildlife biologists from other wildlife biologists in our state.

Other (please specify)

12. How many universities or colleges in your state (enter 0 if none):

offer a B.S. degree that includes wildlife-related sciences (resource management, wildlife management, etc.)?

offer courses in wildlife sciences?

offer a course in urban wildlife management?

Urban Wildlife Research

Urban wildlife research investigates animal behavior, population and community ecology, landscape ecology, conservation and wildlife restoration, wildlife management, wildlife diseases,human-wildlife conflicts, and human perceptions of wildlife specifically in urban or suburban (developed) habitats.

13. Your agency produces publications on:

	Not at all	Occasionally	Frequently
game species (not urban).	○	○	○
non-game species (not urban).	○	○	○
urban wildlife.	○	○	○

14. The animals listed below are known to cause detrimental economic, human health, or habitat effects in urban communities in some states. Please check those that are of special concern in your state. (Check all that apply.)

- ☐ Elk
- ☐ Moose
- ☐ Key deer
- ☐ Mule deer
- ☐ White-tailed deer
- ☐ Black/brown bears
- ☐ Polar bears
- ☐ Foxes
- ☐ Coyotes
- ☐ Bobcats
- ☐ Mountain Lions
- ☐ Raccoons
- ☐ Skunks
- ☐ Opossums
- ☐ Bats
- ☐ Beavers
- ☐ Woodchucks
- ☐ Squirrels
- ☐ Feral cats
- ☐ Feral dogs
- ☐ Feral hogs
- ☐ Blackbirds
- ☐ Cattle egrets
- ☐ Cow birds
- ☐ Crows
- ☐ Ducks
- ☐ Geese
- ☐ Grackles
- ☐ Gulls
- ☐ Hawks/Owls
- ☐ Pigeons
- ☐ Sparrows
- ☐ Starlings
- ☐ Vultures
- ☐ Woodpeckers
- ☐ Alligators
- ☐ Burmese pythons
- ☐ Lizards
- ☐ Rattlesnakes
- ☐ Bull frogs
- ☐ Coqui frogs

Other species or genera not listed above:

15. How is the urban wildlife management program within your agency funded? (Check all that apply.)

- [ ] Pittman–Robertson funds
- [ ] license sales
- [ ] non-game permits
- [ ] donations
- [ ] raised by the public
- [ ] volunteers
- [ ] state general funds
- [ ] we have no funding sources for addressing urban wildlife management concerns

Other (please specify)

16. What limitations prevent greater emphasis on urban wildlife management in your agency? (Check all that apply.)

- [ ] limited funding
- [ ] public opposition
- [ ] opposition within the agency
- [ ] not viewed as scientific
- [ ] not enough urban wildlife biologists
- [ ] there are other more important wildlife management issues to focus on
- [ ] nothing limits urban wildlife management within our agency

Other (please specify)

17. In your opinion, what is (are) the most important urban wildlife issue(s) in your state?

18. Additional comments:

Thank you!

Thank you for your participation in this study! Your responses will be used to assess the current status of urban wildlife management across the nation.

19. Would you like to receive a copy of the results of this study?

- ◯ Yes
- ◯ No

APPENDIX D

DNRS INVOLVED IN THE STUDY

1. Alabama Department of Conservation and Natural Resources
2. Alaska Department of Fish and Game
3. Arizona Game & Fish Department
4. Arkansas Game and Fish Commission
5. California Department of Fish and Game
6. Colorado Division of Wildlife
7. Connecticut Department of Energy and Environmental Protection
8. State of Delaware Division of Fish and Wildlife
9. Florida Fish and Wildlife Conservation Commission
10. Georgia Wildlife Resources Division
11. Hawaii Department of Land & Natural Resources
12. Idaho Department of Fish & Game
13. Illinois Department of Natural Resources
14. Indiana Department of Natural Resources
15. Iowa Department of Natural Resources
16. Kansas Department of Wildlife, Parks, and Tourism
17. Kentucky Department of Fish & Wildlife Resources
18. Louisiana Department of Wildlife and Fisheries
19. Maine Department of Inland Fisheries and Wildlife
20. Maryland Department of Natural Resources
21. Massachusetts Division of Fish and Game
22. Michigan Department of Natural Resources
23. Minnesota Department of Natural Resources
24. Mississippi Department of Wildlife, Fisheries, & Parks
25. Missouri Department of Conservation
26. Montana Fish, Wildlife & Parks
27. Nebraska Game & Parks Commission
28. Nevada Department of Wildlife
29. New Hampshire Fish & Game Department
30. New Jersey Division of Fish & Wildlife
31. New Mexico Department of Game & Fish
32. New York Department of Environmental Conservation
33. North Carolina Wildlife Resources Commission
34. North Dakota Game & Fish Department
35. Ohio Department of Natural Resources
36. Oklahoma Department of Wildlife Conservation
37. Oregon Department of Fish & Wildlife
38. Pennsylvania Game Commission
39. Rhode Island Department of Environmental Management
40. South Carolina Department of Natural Resources

41. South Dakota Game, Fish & Parks Department
42. Tennessee Wildlife Resources Agency
43. Texas Parks & Wildlife Department
44. Utah Division of Wildlife Resources
45. Vermont Fish & Wildlife Department
46. Virginia Department of Game & Inland Fisheries
47. Washington Department of Fish & Wildlife
48. West Virginia Division of Natural Resources
49. Wisconsin Department of Natural Resources
50. Wyoming Game & Fish Department

APPENDIX E

UNIVERSITIES INVOLVED IN THE STUDY

	State	University
1.	Alabama	Auburn University
2.	Alaska	University of Alaska Fairbanks
3.	Arizona	University of Arizona
4.	Arkansas	Arkansas Tech University
5.	Arkansas	University of Arkansas
6.	California	University of California
7.	California	Humboldt State University
8.	California	University of California
9.	Colorado	Colorado State University
10.	Delaware	University of Delaware
11.	Delaware	Delaware State University
12.	Florida	University of Florida
13.	Georgia	University of Georgia
14.	Hawaii	University of Hawaii - Manoa
15.	Idaho	Brigham Young University
16.	Idaho	University of Idaho
17.	Illinois	Southern Illinois University
18.	Illinois	University of Illinois
19.	Indiana	Purdue University
20.	Indiana	Ball State University
21.	Iowa	Iowa State University
22.	Kansas	Emporia State University
23.	Kansas	Kansas State University
24.	Kentucky	Murray State University
25.	Kentucky	Eastern Kentucky University
26.	Louisiana	Louisiana State University
27.	Maine	University of Maine
28.	Maryland	Frostburg State University
29.	Maryland	University of Maryland
30.	Massachusetts	University of Massachusetts
31.	Michigan	Lake Superior State University
32.	Michigan	Michigan Technological University
33.	Michigan	Michigan State University
34.	Minnesota	University of Minnesota - Crookston
35.	Missouri	Northwest Missouri State University
36.	Missouri	Missouri State University
37.	Missouri	University of Missouri
38.	Montana	University of Montana
39.	Montana	Montana State University

40. Nebraska ..... University of Nebraska
41. Nebraska ..... University of Nebraska
42. Nevada ..... University of Nevada
43. New Mexico ..... Western New Mexico University
44. New Mexico ..... Eastern New Mexico University
45. New York ..... State University of New York - Cobleskill
46. North Carolina ..... North Carolina State University
47. North Dakota ..... Valley City State University
48. Ohio ..... University of Rio Grande
49. Ohio ..... Ohio University
50. Oklahoma ..... Oklahoma State University
51. Oregon ..... Oregon State University
52. Pennsylvania ..... Pennsylvania State University
53. Rhode Island ..... University of Rhode Island
54. South Carolina ..... Clemson University
55. South Dakota ..... South Dakota State University
56. South Dakota ..... Dakota Wesleyan University
57. Tennessee ..... Lincoln Memorial University
58. Tennessee ..... Tennessee Technological University
59. Tennessee ..... University of Tennessee - Martin
60. Tennessee ..... University of Tennessee
61. Texas ..... Texas A&M University
62. Texas ..... Texas A&M University-Kingsville
63. Texas ..... Texas State University
64. Texas ..... Texas Tech University
65. Utah ..... Utah State University
66. Utah ..... Brigham Young University
67. Vermont ..... University of Vermont
68. Virginia ..... Virginia Polytechnic Institute and State University
69. Washington ..... Washington State University
70. West Virginia ..... West Virginia University
71. Wisconsin ..... University of Wisconsin
72. Wisconsin ..... University of Wisconsin
73. Wyoming ..... University of Wyoming

APPENDIX F

URBAN WILDLIFE MANAGEMENT PROGRAM AT TEXAS PARKS AND WILDLIFE DEPARTMENT

The Urban Wildlife Program offers public assistance including:

Technical Guidance: Urban biologists provide technical assistance to the public, corporations, private landowners, conservation organizations, and local governments regarding issues pertaining to natural resource management, site assessment, and sensitive wildlife populations.

Public Education: Urban biologists conduct educational programs to various groups including, builders & developers, conservation groups, schools, homeowner associations, city officials, etc. Program topics include but are not limited to: general urban wildlife information, planning for quality open space, native Texas wildlife, habitat restoration, managing conflict between people and wildlife, native landscaping, and many more. Many of the offices offer loaner materials for educators. Contact your local Urban Wildlife Program office for additional topics, educational resources, and upcoming workshops in your area.

City and Regional Planning: Urban biologists offer assistance with public policy, city and park master plans, sustainable development planning, water quality planning, transportation planning, and habitat management for municipalities.

Data Collection and Research: Urban biologists conduct various projects involving biological and environmental surveys, investigative research, and scientific studies in the area of wildlife and resource conservation and management.